Apprenticeship Training

Gasfitter

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Apprenticeship and Industry Training

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Gasfitter

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Apprenticeship and Industry Training System

Apprenticeship is post-secondary education with a difference. It helps ensure Alberta has a steady supply of highly-skilled employees, the foundation of our economy's future health and competitiveness.

Apprentices in more than 50 trades and crafts spend between one and four years learning their trade - 80% of the time on the job under the supervision of a certified journeyman or qualified tradesperson. The balance of the program is technical training in the theory, skills and technologies of their trade.

To become certified journeymen apprentices must learn theory and skills, and they must pass examinations. Requirements for certification—including the content and delivery of technical training—are developed and updated by the Alberta Apprenticeship and Industry Training Board (the Board) and a network of local and provincial industry committees.

The graduate of the Gasfitter apprenticeship training is a journeyman who will:

- be able to apply the standards and regulations of natural and LP gas in order to provide the maximum of safety.
- know the characteristics and proper use of each product.
- be able to install and maintain pipe systems, appliances and equipment using natural or propane gas.
- be proficient in the safe use and maintenance of hand and power tools.
- read and carry out directions as given on blueprints, sketches and plans.
- be familiar with the work of other tradesmen in the construction industry.

Apprenticeship and Industry Training Committee Structure

While government supports Alberta's apprenticeship and industry training system, it is driven by industry, a term which includes both employers and employees. The Alberta Apprenticeship and Industry Training Board, with the support of Alberta Learning, oversees the system. But the system relies on a network of industry committees. These committees include local and provincial apprenticeship committees (LACs and PACs) in the designated trades and occupational committees in the designated occupations, as well as other committees such as provisional committees established before the designation of a new trade or occupation comes into effect. All these committees are composed of equal numbers of employers and employees. The network of industry committees is the foundation of Alberta's apprenticeship and industry training system.

Local Apprenticeship Committees (LAC)

Wherever there is activity in a trade, the Board can set up a LAC. The Board appoints equal numbers of employees and employers for terms of up to three years. The committee appoints a member as presiding officer. Local Apprenticeship Committees:

- monitor the apprenticeship system, and the progress of apprentices in their trade, at the local level.
- help settle certain kinds of issues between apprentices and their employers.
- recommend improvements in apprenticeship training and certification to their trade's provincial apprenticeship committee.
- make recommendations to the Board regarding the appointment of members to their trade's PAC.

Provincial Apprenticeship Committees (PAC)

The Board establishes a PAC for each trade and, based on PAC recommendations, appoints a presiding officer and equal numbers of employees and employers for terms of up to three years. Most PACs have nine members. Provincial Apprenticeship Committees:

- identify the training needs and content for their trade.
- recommend to the Board the standards for training and certification for their trade.
- monitor the activities of local apprenticeship committees in their trade.
- make recommendations to the Board about the designation of trades and occupations.
- determine whether training of various kinds is equivalent to training provided in an apprenticeship program in the trade.
- may participate in resolving any apprenticeship-related disputes between employers and employees.

Gasfitter PAC Members

Mr. L. Bruton	Edmonton	Presiding Officer
Mr. J. Devetten	Calgary	Employer
Mr. K. Forsyth	Calgary	Employer
Mr. D. Nosko	Edmonton	Employer
Mr. D. Smith	Edmonton	Employer
Mr. J. Rutherford	Calgary	Employee
Mr. G. Smale	Calgary	Employee
Mr. R. Alexander	Edmonton	Employee
Mr. K. Ouderkirk	Edmonton	Employee

The Alberta Apprenticeship and Industry Training Board (Board)

The mandate of the Alberta Apprenticeship and Industry Training Board relates to the standards and requirements for training and certification in programs under the *Apprenticeship and Industry Training Act*. The Board provides advice to the Minister of Learning on the training and certification of people in designated trades and occupations and on the needs of the Alberta labour market for skilled and trained persons. The Board also makes orders and regulations respecting standards and requirements for apprenticeship programs and the training of apprentices and for training and certification in designated trades and occupations, and the criteria or requirements for granting and recognizing trade and other certificates.

The 13-member Board consists of a chairman, eight members representing trades and four members representing other industries. The trades and other industry members are equally represented by employer and employee representatives.

Safety Education

Safe working procedures and conditions, accident prevention and the preservation of health are of primary importance in apprenticeship programs in Alberta. These responsibilities are shared and require the joint efforts of government, employers, employees and the public. Therefore, it is imperative that all parties become aware of circumstances that may lead to injury or harm. Safe learning experiences and environments can be created by controlling the variables and behaviours that may contribute to or cause an accident or injury.

It is generally recognized that a safe attitude contributes to an accident free environment. Everyone will benefit as a result of a healthy, safe attitude towards prevention of accidents.

A tradesperson is possibly exposed to more hazards than any other person in the work force and, therefore, should be familiar with and apply the Occupational Health and Safety Act and Regulations dealing with personal safety and the special safety rules applying to each task.

Legal and Administrative Aspects of Safety

Accident prevention and the provisions of safe working conditions are the responsibilities of an employer and employee.

Employer's Responsibilities

The employer is responsible for:

- providing and maintaining safety equipment, and protective devices.
- ensuring proper safe work clothing is worn.
- enforcing safe working procedures.
- providing safeguards for machinery, equipment and tools.
- observing all accident prevention regulations.
- training employees in the safe use and operation of equipment.

Employee's Responsibilities

The employee is responsible for:

- working in accordance with the safety regulations pertaining to the job environment.
- working in such a way as not to endanger themselves or fellow employees.

Workplace Health and Safety's Responsibilities:

Workplace Health and Safety (Alberta Human Resources and Employment) will conduct periodic inspections of the workplace to ensure that safety regulations for industry are being observed.

Technical Training Establishment

Alberta Learning, Apprenticeship and Industry Training offer your apprenticeship training program. Staff and facilities for delivering the program are supplied by:

- Northern Alberta Institute of Technology (Patricia campus)
- Southern Alberta Institute of Technology (Main campus)

Procedures for Recommending Revisions to the Course Outline

Apprenticeship and Industry Training, Industry Programs and Standards has prepared this course outline in partnership with the Gasfitter Provincial Apprenticeship Committee.

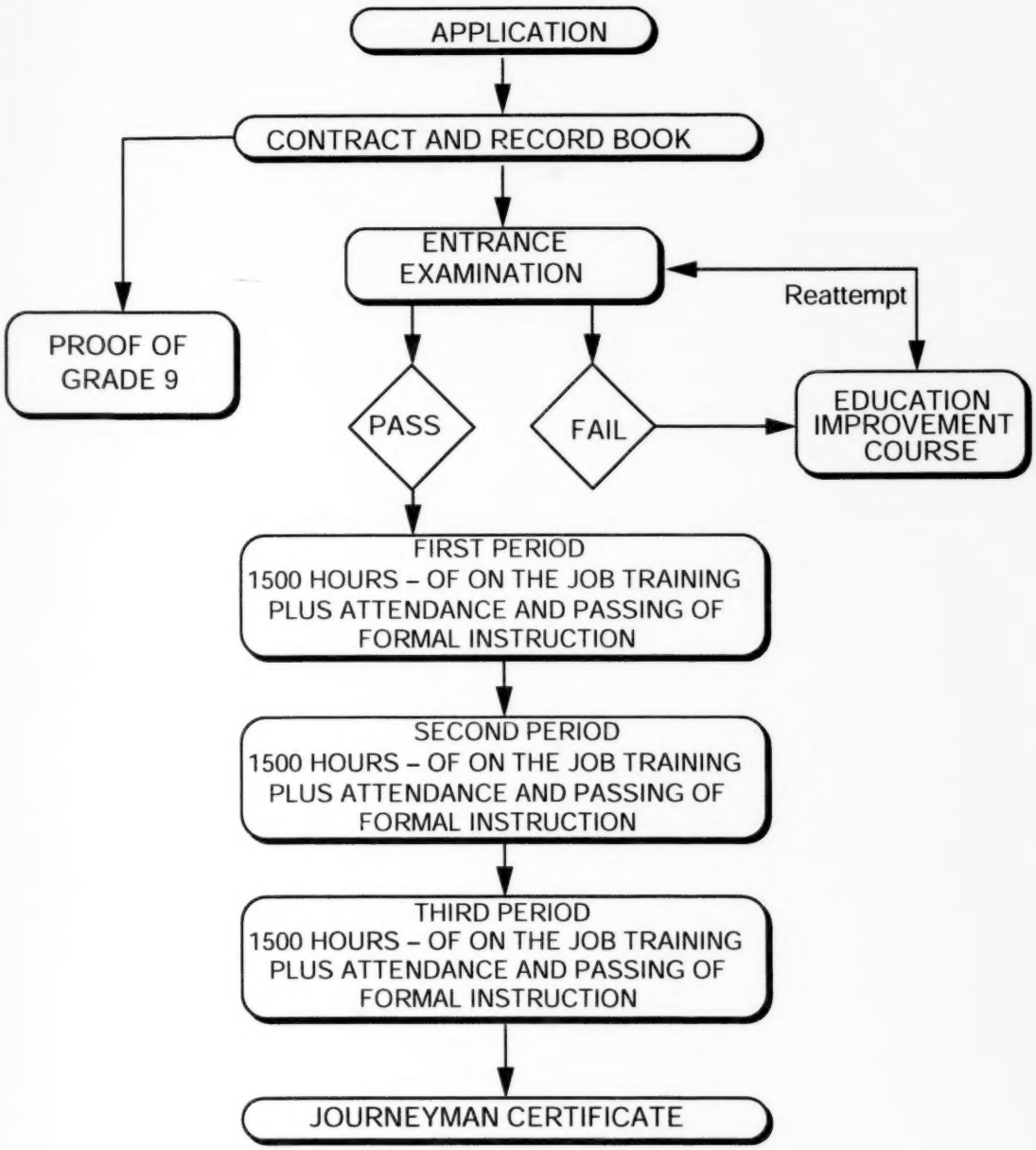
This course outline was approved on June 20, 2005 under the authority of the Alberta Apprenticeship and Industry Training Board on a recommendation from the Provincial Apprenticeship Committee. Valuable input is acknowledged from industry and the institutions.

Any concerned citizen or group in the Province of Alberta may make recommendations for change by writing to:

Gasfitter Provincial Apprenticeship Committee
c/o Industry Programs and Standards
Apprenticeship and Industry Training
10th floor, Commerce Place
10155 - 102 Street
Edmonton, AB T5J 4L5

It is requested that recommendations for change refer to specific areas and state references used. Recommendations received will be placed before regular meetings of the Provincial Apprenticeship Committee.

Apprenticeship Route toward Certification


APPLICATION
CONTRACT AND RECORD BOOK
PROOF OF GRADE 9
ENTRANCE EXAMINATION
Reattempt
PASS
FAIL
EDUCATION IMPROVEMENT COURSE
FIRST PERIOD
1500 HOURS – OF ON THE JOB TRAINING PLUS ATTENDANCE AND PASSING OF FORMAL INSTRUCTION
SECOND PERIOD
1500 HOURS – OF ON THE JOB TRAINING PLUS ATTENDANCE AND PASSING OF FORMAL INSTRUCTION
THIRD PERIOD
1500 HOURS – OF ON THE JOB TRAINING PLUS ATTENDANCE AND PASSING OF FORMAL INSTRUCTION
JOURNEYMAN CERTIFICATE

Gasfitter Training Profile

First Period
(8 Weeks 30 Hours per Week – Total Of 240 Hours)

Residential Gasfitting

SECTION ONE

MATHEMATICS FOR GASFITTING — 24 Hours

A	B	C
Trade Mathematics — 6 Hours	Linear, Perimeter, Area, Volume and Capacity Measurements — 6 Hours	Percentage Calculations — 4 Hours
D	**E**	
Temperature and Heat Calculations — 6 Hours	Simple Offset — 2 Hours	

SECTION TWO

BLUEPRINT READING FOR GASFITTING — 16 Hours

A	B	C
Scales — 2 Hours	Blueprint Symbols — 2 Hours	Mechanical Drawings — 4 Hours
D		
Residential Blueprints — 8 Hours		

SECTION THREE

BASIC SCIENCES FOR GASFITTING — 36 Hours

A	B	C
Properties of Matter — 8 Hours	Pressure and the Atmosphere — 6 Hours	Temperature and Heat — 11 Hours
D	**E**	**F**
Principles of Electricity — 4 Hours	Properties of Gases — 6 Hours	Manufacture and Distribution of Fuel Gas — 1 Hour

SECTION FOUR

GASFITTING BURNERS AND COMBUSTION — 20 Hours

A	B	C
Pressure Gauges — 2 Hours	Principle of Combustion — 4 Hours	Natural Draft Burners for Category 1 and 2 Appliances — 6 Hours
D	**E**	
Residential Appliance Burner Adjustments — 4 Hours	Residential Pilots and Pilot Burners — 4 Hours	

SECTION FIVE

GASFITTING PIPE INSTALLATION — 38 Hours

A	B	C
Introduction to Workplace Hazardous Materials Information Systems (WHMIS) — 1 Hour	Rigging, Lifting and Climbing Equipment — 12 Hours	Pipe, Tube and Tubing — 25 Hours

SECTION SIX

GASFITTING THEORY AND CODE INTERPRETATION — 40 Hours

A	B	C
Introduction to the Gas Codes and Alberta Plumbing and Gas Safety Bulletins — 10 Hours	Introduction to Venting — 10 Hours	Pressure Regulators — 8 Hours
D	**E**	
Gas and Liquid Meters — 2 Hours	Residential Gas, Electrical and Electronic Controls — 10 Hours	

SECTION SEVEN

GAS SHOP AND LAB WORK — 66 Hours

A	B	C
Safe Use of Tools — 6 Hours	Hot Tapping — 3 Hours	Pipe Jointing Techniques — 15 Hours

D	E	F
Pipe, Tube and Tubing Cold Bending 4 Hours	Use of Pressure Gauges and Manometers 3 Hours	Meter Reading and Clocking 3 Hours
G	H	I
Thermocouple Analysis 3 Hours	Burner Adjustments 3 Hours	Drilling and Sizing Orifices 4 Hours
J		
Residential Appliance Gas Controls 22 Hours		

SECOND PERIOD

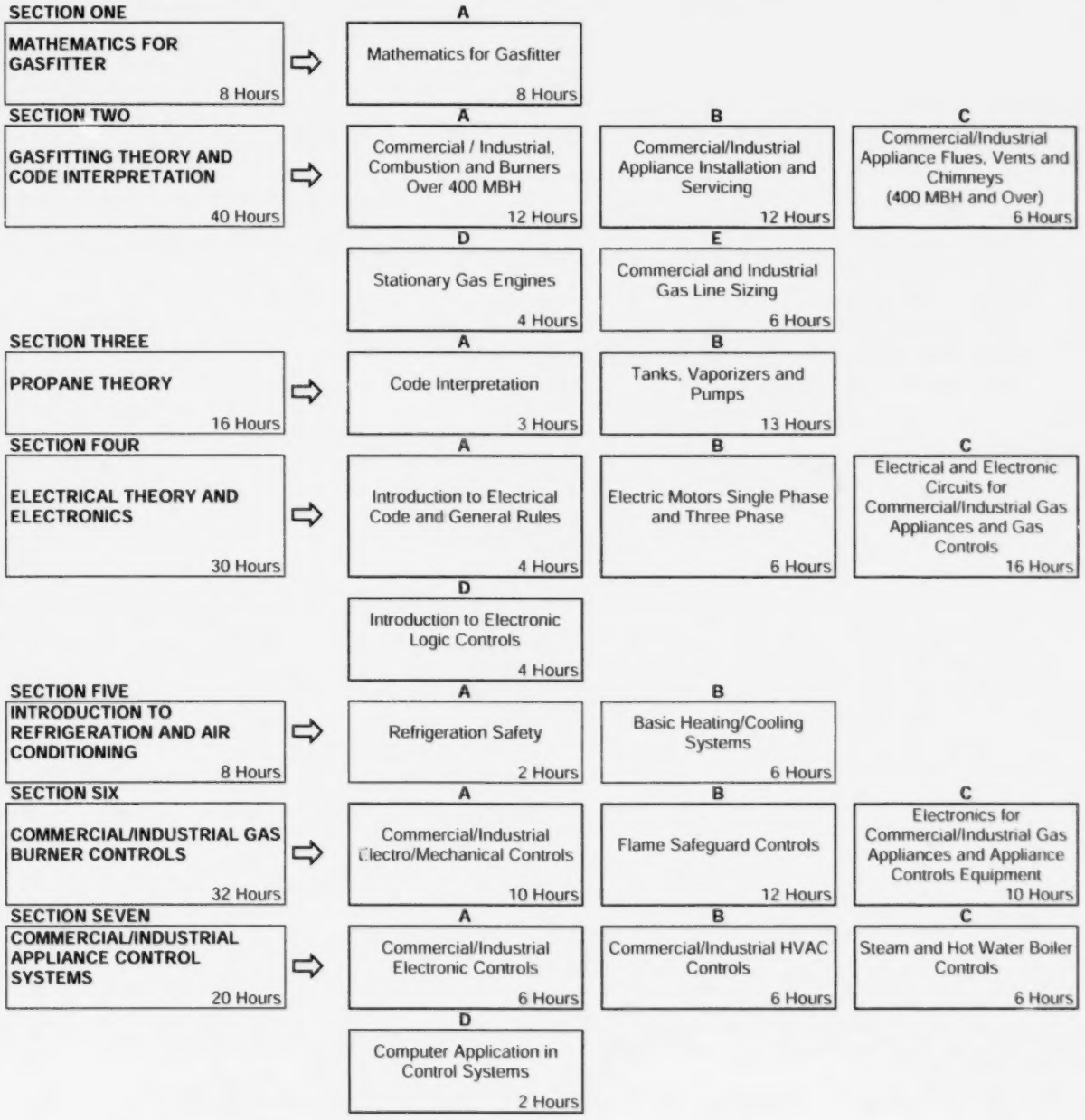
(8 Weeks 30 Hours per Week – Total of 240 Hours)

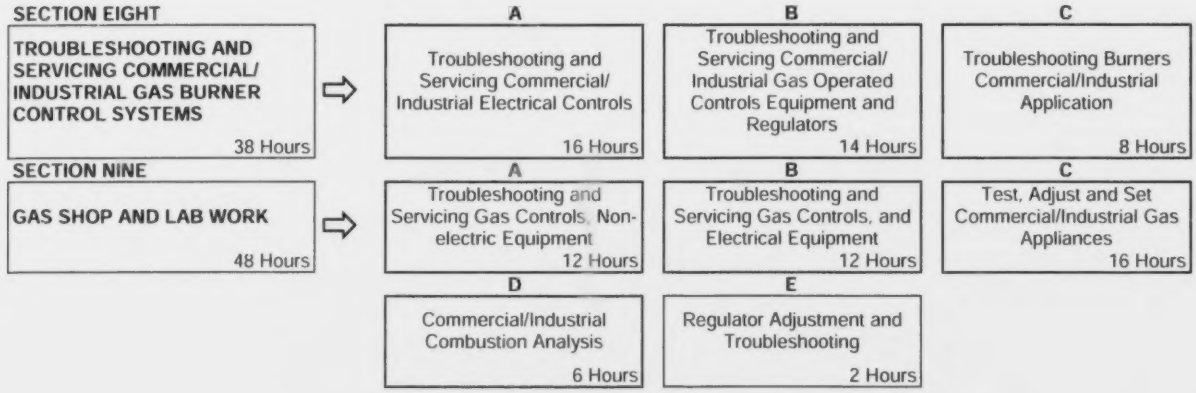
Residential and Introduction to Commercial up to 400 MBH

SECTION ONE	A	B	C
MATHEMATICS FOR GASFITTER 22 Hours ⇨	Trade Mathematics 6 Hours	Trade Specific Mathematics 10 Hours	Introduction to Computers 6 Hours
SECTION TWO	A	B	C
BLUEPRINT READING FOR GASFITTING 16 Hours ⇨	Residential and Commercial Blueprints 10 Hours	Architectural Specification 3 Hours	Mechanical Specifications 3 Hours
SECTION THREE	A	B	C
GASFITTING THEORY AND CODE INTERPRETATION 70 Hours ⇨	Residential and Commercial Pipe Installation 12 Hours	Two Pound Gas (14 Kpa) 2 Hours	Residential and Commercial Gas Line Sizing 6 Hours
	D	E	F
	Gas Line Installation 6 Hours	Installation and Sizing of Venting Systems for Appliances up to 400 MBH 18 Hours	Combustion Air Requirements for Residential/Commercial Appliances up to 400 MBH 10 Hours
	G	H	
	Installation Requirements for Residential/Commercial Appliances up to 400 MBH 6 Hours	Propane Cylinder Systems 10 Hours	
SECTION FOUR	A	B	C
ELECTRICAL THEORY 72 Hours ⇨	Electrical and Electronic Principles 16 Hours	Wiring Diagrams 18 Hours	Non-Electrical, Electrical and Electronic Control Theory 14 Hours
	D	E	
	Electrical Circuits and Systems 16 Hours	Transformers 8 Hours	
SECTION FIVE	A	B	
BURNERS AND COMBUSTION 24 Hours ⇨	Natural and Fan Assisted Draft Appliances 12 Hours	Induced Burners and Combustion 12 Hours	
SECTION SIX	A	B	C
GAS SHOP AND LAB WORK 36 Hours ⇨	Wiring Control Circuits 12 Hours	Circuits, Control and Appliance Testing up to 400 MBH 12 Hours	Troubleshooting Electrical Control Components up to 400 MBH 12 Hours

THIRD PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)

High Efficiency Appliances and Controls over 400 MBH Commercial/and Industrial Application





NOTE: The hours stated are for guidance and should be adhered to as closely as possible. However, adjustments must be made for rate of apprentice learning, statutory holidays, registration and examinations for the training establishment and Apprenticeship and Industry Training.

FIRST PERIOD TECHNICAL TRAINING

GASFITTER TRADE
COURSE OUTLINE
RESIDENTIAL GASFITTING

SECTION ONE: ..... MATHEMATICS FOR GASFITTING ..... 24 HOURS

A. Trade Mathematics ..... 6 Hours

1. Add, subtract, multiply and divide numbers:
   a) whole numbers
   b) decimal numbers
   c) fractional numbers
   d) mixed numbers
2. Calculate squares mathematically.
3. Calculate square roots mathematically.
4. Solve Pythagoreans' theorem involving 3-4-5 triangles.
5. Convert fractional values to decimal values (to fractional thirty-seconds).
6. Convert decimal values to fractional values.
7. Convert fractional inches to decimal inches (to fractional sixteenths).
8. Convert decimal inches to fractional inches.
9. Interconvert metres, centimeters and millimeters.

B. Linear, Perimeter, Area, Volume and Capacity Measurements ..... 6 Hours

1. State the formulas for calculating the perimeter of flat planes.
2. Calculate the perimeter of regular shaped figures in both imperial and SI units.
3. State the formula for calculating the area of a flat plane.
4. Calculate areas of regular shaped figures in both imperial and SI units.
5. State the formulas for calculating the surface area of regular shaped solids, tanks and cylinders.
6. Calculate surface areas of regular shaped tanks and cylinders in both imperial and SI units.
7. State the formulas for calculating the volume of regular shaped solids, tanks and cylinders.
8. Calculate the volume of regular shaped tanks and cylinders in both imperial and SI units.
9. State the formulas for calculating the capacity of regular shaped solids, tanks and cylinders.
10. Calculate the capacity of regular shaped tanks and cylinders in both imperial and SI units.

C. Percentage Calculations ..... 4 Hours

1. Calculate percentages of known values.
2. Calculate real values from percentage values.
3. Calculate free area of grills from dimensions and percentage free area in both SI and imperial units.
4. Calculate appliance inputs and outputs in both SI and imperial units.
5. Calculate discounts.
6. Wage rates.
7. Calculate income and deductions.

D. Temperature and Heat Calculations ..... 6 Hours

1. Convert Fahrenheit temperatures to Celsius and vise-versa.
2. Change standard temperatures to Absolute temperatures and vise-versa.
3. Define the term heat as it applies to the trade of Gasfitting in both SI and imperial units.
4. State the specific heat capacity of water and air in both SI and imperial units.
5. Calculate heat energy of water contained in regular shaped vessels in both SI and imperial units.
6. Calculate heat contents of air contained in regular shaped buildings in both SI and imperial units.
7. Use a table of specific heat capacities to determine the specific heat capacity of materials in both SI and imperial units.
8. Calculate heat contents of materials contained in regular shaped vessels in both SI and imperial units.
9. State the specific latent heat capacity of water, ice and propane liquid in both imperial and SI units.
10. Use the specific latent heat capacity to determine the heat absorbed to convert ice into water, water into steam and propane liquid into propane gas.
11. Use the specific latent heat capacity to determine the heat absorbed to convert ice into water, water into steam and propane liquid into propane gas including changing the temperature in both imperial and SI units.

E. Piping Offsets ..... 2 Hours

1. Calculate simple 45° piping offsets in both SI and imperial units.

SECTION TWO: BLUEPRINT READING FOR GASFITTING ..... 16 HOURS

A. Scales ..... 2 Hours

1. Read and interpret blueprint scales drawn in SI units.
2. Read and interpret blueprint scales drawn in imperial units.

B. Blueprint Symbols ..... 2 Hours

1. List and describe common blueprint symbols for all types of fittings and valves.
2. List and describe common blueprint symbols for all types of gasfitting appliances.

C. Mechanical Drawings ..... 4 Hours

1. Interpret mechanical drawings showing orthographic projections.
2. Interpret mechanical drawings showing isometric projections.

D. Residential Blueprints ..... 8 Hours

1. Read and interpret residential blueprint legends.
2. Read and interpret residential blueprint specification.
3. Read and interpret residential site plan blueprints in both SI and imperial units.
4. Read and interpret residential blueprints of plot plans, sectional drawings and detail drawings in both SI and imperial units.

SECTION THREE: BASIC SCIENCES FOR GASFITTING ..... 36 HOURS

A. Properties of Matter ..... 8 Hours

1. Define and explain the meaning of the term matter.
2. List and explain the differences and commonalties between:
   a) element
   b) compounds
   c) mixtures
   d) solutions
3. Define and explain the three states of matter:
   a) solid
   b) liquid
   c) gas

4. List and describe changes of state of matter:
   a) physical change
   b) chemical change

5. Describe the properties of matter in different states.

6. Define and explain the meaning of the terms:
   a) adhesion
   b) cohesion
   c) surface tension
   d) capillarity

7. Explain the applications of the principles of: adhesion, cohesion, surface tension and capillarity in the gasfitting trade with reference to:
   a) water filled manometers;
   b) soldering and brazing, use of fluxes.

8. Define and explain the meaning of the term density.

9. State the density of water in both SI and imperial units including:
   a) kilograms/cubic metre;
   b) kilograms/litre;
   c) pounds per cubic foot;
   d) pounds per imperial gallon;
   e) pounds per US gallon;
   f) pounds per cubic inch;
   g) ounces per cubic inch.

10. Use a table of densities to determine the density of matter including:
    a) air;
    b) propane gas and liquid;
    c) methane;
    d) mercury;
    e) other solids, liquids and gases.

11. Calculate the mass of the contents of various shaped solids and storage vessels using densities.

12. Define and explain the meaning of the term relative density.

13. State the relative density of water in both SI and imperial units.

14. State the relative density of mercury in both SI and imperial units.

15. State the relative density of propane liquid in both SI and imperial units.

16. State the relative density of methane gas in both SI and imperial units.

17. State the relative density of propane gas in both SI and imperial units.

18. Use a table of relative densities to determine the relative density of various materials.

19. Calculate the mass of the contents of various shaped solids and storage vessels using relative densities.

20. Define and explain the meaning of the term buoyancy.

21. State the three laws of buoyancy.

22. Calculate the buoyant force on various regular shaped solids submersed in water.

B. Pressure and the Atmosphere ..... 6 Hours

1. Define and explain the meaning of the terms pressure and force.

2. State the five principles of hydrostatic pressure.

3. State the pressure constants used for calculating pressure in both SI and imperial units including:
   a) kPa/metre head;
   b) psi/foot head;
   c) psi/inch water column;
   d) psi/inch mercury column;
   e) ozs/sq inch and inches water column.

4. Interconvert pressures:
   a) kPa and metres head
   b) psi and feet head
   c) psi and inches water column
   d) psi and inches mercury column
   e) oz./sq. inch and inches water column

5. List and describe the properties of the atmosphere as it relates to the trade.

6. State the pressure of the atmosphere at sea level in both SI and metric units.

7. Describe the effects of altitude on atmospheric pressure.

8. Interconvert gauge and absolute pressures in both SI and imperial units.

9. List and describe the principles of Boyle's law on the behavior of perfect gases.

C. Temperature and Heat ..... 11 Hours

1. Define and explain the concept of temperature.

2. Explain the differences and commonalties between heat and temperature.

3. List and describe the temperature scales:
   a) Celsius
   b) Fahrenheit

4. List and describe the principles of Charles' law on the behavior of perfect gases in both SI and imperial units.

5. Define the term heat in both SI and imperial units.

6. Explain the differences and commonalties between heat and temperature.

7. Explain the meaning of the terms:
   a) British thermal units
   b) MBH
   c) therms
   d) oules
   e) watts

8. Define and explain the meaning of the terms:
   a) specific heat capacity
   b) sensible heat
   c) specific latent heat capacity
   d) latent heat
   e) total heat

9. State the specific heat capacity of water and air in both imperial and SI units.

10. Calculate heat contents of water contained in regular shaped vessels in both SI and imperial units.

11. Calculate heat contents of air contained in regular shaped buildings in both SI and imperial units.

12. Use a table of specific heat capacities to determine the specific heat capacity of materials in both SI and imperial units.

13. Calculate heat contents of materials contained in regular shaped vessels in both SI and imperial units.

14. State the specific latent heat capacity of water, ice and propane liquid in both imperial and SI units.

15. Use the specific latent heat capacity to determine the heat absorbed to convert ice into water, water into steam and propane liquid into propane gas without changing the temperature in both imperial and SI units.

16. Use the specific latent heat capacity to determine the heat absorbed to convert ice into water, water into steam and propane liquid into propane gas including changing the temperature in both imperial and SI units.

17. List and explain the three methods of heat transfer:
   a) conduction
   b) convection
   c) radiation

18. Describe applications of each method of heat transfer as it applies to the trade of gasfitting.

19. Define and explain the terminology and principles of expansion and contraction.

20. Define coefficients of linear expansion of solids.

21. Use tables of coefficients of expansion to calculate the coefficients of expansion of particular materials in both SI and imperial units.

22. State the formula and calculate linear expansion in pipes.

23. List and describe useful applications, detrimental of expansion and contraction in the gasfitting industry.

D. Principles of Electricity..... 4 Hours

1. Describe the electron theory of electricity.

2. Define and explain the meaning the terms:
   a) amps
   b) volts
   c) ohms

3. Define and explain the principles of direct current flow of electricity.

4. Calculate Ohm's law in direct current circuits.

5. Define and explain the principles of alternating current flow of electricity.

6. Calculate Ohm's law in alternating current circuits.

7. List and describe simple electrical circuits:
   a) series circuits
   b) parallel circuits
   c) series/parallel circuits
   d) series and parallel circuits

8. Solve Ohm's law calculations for any unknown value in electrical circuits.

9. Explain the principles of electromagnetism.

10. List and explain operating principles of electromagnetic devices used in the gasfitting industry:
    a) transformers
    b) solenoids

E. Properties of Gases ..... 6 Hours

1. State the chemical formula of:
   a) methane;
   b) propane;
   c) butane;
   d) carbon dioxide;
   e) carbon monoxide;
   f) oxygen;
   g) nitrogen;
   h) water.

2. State the relative density of propane liquid in both SI and imperial units.

3. Use the relative density of propane liquid to calculate the mass of propane liquid in propane tanks and cylinders in both SI and imperial units.

4. State the relative density of natural and propane gases.

5. State the heating value of gases in both SI and imperial units:
   a) methane
   b) propane
   c) propane liquid

6. Use a table of heating values to determine the heating values of other fuels.

7. Use the heating value of gases to interconvert heat capacity and volumes in both SI and imperial units:
   a) joules and cubic metres
   b) joules and litres
   c) Btu's and cubic feet
   d) Btu's and imperial gallons
   e) Btu's and US gallons

8. State the liquefaction ratio of propane liquid.

9. Use the liquefaction ratio to interconvert liquid and gas volumes:
   a) cubic metres of gas and cubic metres of liquid
   b) litres of gas and litres of liquid
   c) cubic feet of gas and cubic feet of liquid
   d) cubic feet of gas and imperial gallons of liquid
   e) cubic feet of gas and US gallons of liquid

10. State the latent heat of vaporization of propane liquid.

11. Use the properties of gases to describe the behavior of the gases under specific conditions.

12. Use the properties of gases as appropriate to calculate trade related problems.

F. Manufacture and Distribution of Fuel Gas ..... 1 Hour

1. Describe the general processes by which natural gas is produced.

2. Describe the general processes by which natural gas is distributed from the wellhead to the customer.

3. List and describe the various components of a gas distribution system.

SECTION FOUR: ..... GASFITTING BURNERS AND COMBUSTION ..... 20 HOURS

A. Pressure Gauges ..... 2 Hours

1. Identify the types of U-tube water manometers in both SI and imperial units:
   a) direct reading
   b) indirect reading

2. Correctly fill manometers:
   a) water filled
   b) manometer fluids

3. List and describe correct use of manometers for measuring various gas pressures.

4. Use manometers to measure gas pressures:
   a) standing line pressure
   b) operating line pressure
   c) manifold pressure

5. Use manometers to diagnose gas pressure problems:
   a) regulator lock-up
   b) regulator creep
   c) pressure loss
   d) stoppages in gas lines
   e) pressure oscillations

6. List and describe correct procedures when using manometers for testing for gas leaks.

7. Identify types of mechanical low pressure gauges in both SI and imperial units:
   a) analog
   b) digital

8. List and describe correct use of mechanical gauges for measuring low gas pressures.

9. Describe use mechanical gauges to measure low gas pressures:
   a) standing line pressure
   b) operating line pressure
   c) manifold pressure

10. Describe use manometers to diagnose gas pressure problems for low-pressure applications:
    a) regulator lock-up
    b) regulator creep
    c) pressure loss
    d) stoppages in gas lines
    e) pressure oscillations

11. List and describe correct procedures when using mechanical pressure gauges for testing for gas leaks.

B. Principle of Combustion ..... 4 Hours

1. Define combustion terms.

2. Define and explain the flammability of gases:
    a) range of flammability
    b) upper limit of flammability
    c) lower limit of flammability
    d) ignition temperature

3. List and explain the properties of combustion of gases:
    a) rate of flame propagation
    b) flashback
    c) turndown ratio

4. Explain the principles of combustion as a chemical change for methane and propane.

5. Read and describe combustion chemical equations.

6. List and describe the products of complete and incomplete combustion.

7. State the characteristics of products of both complete and incomplete combustion.

8. Explain the physiological effects of human asphyxiation by carbon monoxide poisoning.

9. State the air required for complete combustion of gas:
    a) theoretical air for combustion
    b) excess air required

10. List and define the combustion air terms:
    a) primary
    b) secondary
    c) excess

11. Describe the characteristics of aerated and non-aerated flames.

12. Describe aerated flames:
    a) oxidizing
    b) carbonizing
    c) neutral

13. Describe flame adjustment techniques for:
    a) primary air;
    b) secondary air;
    c) excess air.

C. Natural Draft Burners for Category 1 and 2 Appliances ..... 6 Hours

1. List and define common burner terminology.

2. Describe the characteristics of gas burners and flame patterns:
   a) inshot
   b) upshot

3. List and describe the features of gas burners and flame patterns:
   a) aerated
   b) non-aerated

4. Identify and name the parts of gas burners and describe the function of each:
   a) orifice
   b) primary air inlet
   c) primary air shutter adjustment
   d) mixing tube
   e) venturi throat
   f) burner head
   g) burner ports

5. List the procedure used to measure and adjust manifold pressures in both SI and imperial units.

6. Convert gas volume consumptions to heat flow consumptions in both SI and imperial units.

7. Calculate reduction in gas consumption for high altitude ratings:
   a) sea level to high altitude
   b) sea level to special high altitude applications

8. Recognize and name different styles of burner orifices:
   a) plug
   b) cap
   c) adjustable cap
   d) adjustable spud
   e) simplex burner controls
   f) duplex burner controls

9. Describe the correct procedures to be used when setting adjustable orifices for the correct burner consumption using correct manifold pressure and meter clocking techniques for both single and multiple orifices using both simplex and duplex orifices.

10. Use orifice sizing charts to size fixed orifices for single and multiple burner installations.

11. Use orifice sizing charts to determine orifice drill sizes required for drilling orifices.

12. Describe the correct procedures to be used when drilling gas orifices using hand-drilling techniques.

13. List and describe the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* pertaining to orifice sizing.

14. List and describe appliance altitude rating for gas appliances installed in the province of Alberta.

15. List by name, identify and describe characteristics of various gas orifices.

16. Size orifices for specific gas consumptions and pressures in both SI and imperial units, using standard orifice sizing charts.

17. Interpolate, where necessary, in orifice sizing charts to determine correct orifice size for gas pressures not listed in the orifice-sizing chart.

18. Determine drill sizes for drilling gas orifices for specific gas consumptions and gas pressures.

19. Drill orifices for gas burners.

20. Clock meters to determine correct gas consumption for gas burners in both SI and imperial units.

21. Explain CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* requirements for sizing and drilling orifices for gas burners.

22. Recognize and name different styles of forced and induced draft burners; exhaust motors and purge dams.

23. List and describe features and flame patterns.

24. Describe the combustion sequence of each application.

D. Residential Appliance Burner Adjustments..... 4 Hours

1. Determine the correct ratings of gas appliances from the rating plates and manufacturer's data or instruction sheets.

2. Explain the altitude rating of gas appliances:
   a) sea level
   b) high altitude
   c) special applications

3. Check appliance for suitability for use in Alberta.

4. List approval agencies accepted for approval of gas appliances installed in Alberta.

5. Explain the principles of low pressure meter clocking.

6. List the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* pertaining to gas appliance adjustments and installer's responsibility.

E. Residential Pilots and Pilot Burners..... 4 Hours

1. List and define common pilot burner terminology.

2. Describe the characteristics of pilot burners:
   a) aerated
   b) non-aerated

3. List and describe the features of pilot burners flame patterns:
   a) aerated
   b) non-aerated

4. Identify and name the parts of aerated pilot burners:
   a) orifice
   b) primary air inlet
   c) primary air filter screen
   d) mixing tube
   e) venturi throat
   f) burner head
   g) burner ignition flame
   h) safety control flame

5. Identify and name the parts of post-aerated pilot burners:
   a) orifice
   b) primary air inlet
   c) burner head
   d) burner ignition flame
   e) safety control flame

6. List and describe types of gas pilots:
   a) standing pilot
   b) interrupted pilot
   c) intermittent pilot
   d) proved pilot
   e) expanding pilot

7. State the primary purpose of a gas pilot.

8. List and describe burner ignition tests performed on all pilots.

9. Describe correct installation and locations of pilots relative to main burners.

10. State the secondary purpose of a proved pilot.

11. List and describe the operational test performed on proved pilots energizing a thermocouple.

12. List and describe methods of installing thermocouples and thermopiles on standard circuits.

13. Wire thermopiles into safe hook-up circuits.

14. Wire thermopiles into 100~ safety circuits.

15. Describe how to perform thermocouple analysis tests on a proved pilot:
   a) open circuit test
   b) closed circuit test
   c) response time test
   d) drop out point test
   e) turn down test
   f) safety shut down test

16. Describe how to perform thermopile analysis tests on a proved pilot:
   a) open circuit test
   b) closed circuit test
   c) response time test
   d) drop out point test
   e) effective ignition test
   f) safety shut down test

SECTION FIVE: ..... GASFITTING PIPE INSTALLATION ..... 38 HOURS

A. Introduction to Workplace Hazardous Materials Information Systems (WHMIS) ..... 1 Hour

NOTE: Introductory film available regarding WHMIS from O.H.S.

1. Describe what WHMIS is, its rational and major elements.

2. List and describe some of the health effects hazardous materials may cause that are used in the pipe trades.

3. List and explain the classes of the *Hazardous Products Act.*

4. Define what is meant by a WHMIS label distinguish between supplier and workplace labels and other means of identification.

5. Describe what is meant by the following classifications:
   a) prohibited product
   b) restricted product
   c) controlled product

6. Explain what a Material Safety Data Sheet (MSDS) I— its purpose and limitations.

7. Describe the roles and responsibilities of employer, supplier and worker in the education of workers regarding WHMIS.

B. Rigging, Lifting and Climbing Equipment ..... 12 Hours

1. Recognize and name the different types of fiber rope: natural and synthetic.

2. State characteristics of the different types of fiber rope.

3. State safe working loads of different types of fiber rope.

4. State useful and detrimental applications of different types of fiber rope for lifting and pulling operations.

5. List and describe the common parts of a fiber rope.

6. State characteristics and uses of parts of a fiber rope.

7. Recognize and name the different knots used on fiber ropes:
   a) square
   b) bowline
   c) timber hitch
   d) clove hitch
   e) round turn and half hitch

8. State applications of the different knots used on fiber ropes.

9. State safety factors for various knots and hitches.

10. Tie knots and hitches.

11. Use knots in correct applications for lifting and pulling operations, and for use of safety harnesses.

12. Recognize and name the different types of wire rope.

13. State characteristics of the different types of wire rope.

14. State safe working loads of different types of wire rope.

15. State useful and detrimental applications of different types of wire rope for lifting and pulling operations.

16. List and describe the common parts of a wire rope.

17. State characteristics and uses of parts of a wire rope.

18. Recognize and name the different slings used for hoisting pipe appliances and components.

19. State characteristics of different types of slings.

20. State safe working loads of different types of slings.

21. State useful and detrimental applications of different types of slings for lifting operations.

22. Calculate tension and loads in slings at different angles.

23. State strengths of shackles, clamps and other devices.

24. List and describe maintenance of slings and hoisting equipment.

25. Name and describe cranes, hoists and cherry pickers.

26. List and describe applications of cranes, hoists and cherry pickers in the gasfitting industry.

27. Move and position the equipment for correct operation.

28. Display correct crane operator hand signals.

29. Describe the methods to protect equipment from physical and mechanical damage when lifting.

30. Describe methods of blocking loads.

31. List and describe the methods of securing loads for hoisting.

32. Raise, lower and position loads by using appropriate hand signals to operator.

33. Recognize and name the different styles of steps and ladders used in the construction industry.

34. Erect ladders and steps in a safe manner.

35. State regulations pertaining to the correct use of ladders in the construction industry.

36. Use ladders in a correct, safe and workman-like manner.

37. Recognize and name the different types of scaffolds and platforms used in the construction industry.

38. Erect Scaffolds and platforms in a safe manner.

39. State the regulations pertaining to the correct use of scaffolds and platforms in the construction industry.

40. Describe correct safety practices used when using scaffolds and platforms:
    a) personal safety
    b) personnel safety
    c) jobsite safety
    d) public safety

41. Use scaffolds and platforms in a correct, safe and workmanlike manner.

C. Pipe, Tube and Tubing..... 25 Hours

Threaded pipe..... 5 Hours

1. List and describe types and materials used for ferrous pipe in the gasfitting trade.

2. List and describe schedule numbers and grades of ferrous pipe manufactured.

3. Describe pressure ratings of different pipe schedules and grades.

4. Recognize and state pipe sizes.

5. Recognize and describe different protective coatings applied to gas piping.

6. Interpret CSA B 149.1 Gas Codes and Alberta Safety Services Plumbing and Gas Standards pertaining to gas piping.

7. Recognize, name and size threaded pipefittings used on steel pipe including insulated unions.

8. Describe pressure ratings of pipefittings.

9. List and describe the correct fabrication processes for threaded pipe:
   a) measure
   b) mark
   c) cut
   d) ream
   e) thread

10. List and describe the correct tools needed for cutting a pipe thread using hand tools.

11. List and describe the correct procedures to be used when threading pipe using hand operated tools.

12. List and describe the correct use of a nipple chuck using hand threading tools.

13. List and describe the procedures for using hand operated pipe dies to cut close nipples.

14. List and describe the correct tools needed for cutting a pipe thread using power tools.

15. List and describe the correct procedures to be used when threading pipe using power operated tools.

16. Thread pipe using power tools.

17. List and describe the correct use of a nipple chuck using a power vise.

18. List and describe the correct installation procedures used for the installation of threaded gas pipe.

19. Describe correct safety practices to be used when installing gas piping:
   a) personal safety
   b) personnel safety
   c) jobsite safety
   d) public safety

20. Interpret CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* pertaining to the installation of ferrous, gas piping and fittings in both indoor and outdoor, above ground and below ground pipe installations.

Welded pipe fittings ..... *2 Hours*

1. Recognize, name and size welded pipefittings used on steel pipe.

2. Describe pressure ratings of pipefittings.

3. List and describe correct fabrication processes for welded pipe:
   a) measure
   b) mark
   c) cut
      i) ream
      ii) bevel
      iii) tack

4. List and describe the correct tools and welding equipment needed for preparing a welded pipe joint to the "tacked" stage.

5. Describe correct safety practices to be used when tacking welded pipe:
   a) personal safety
   b) personnel safety
   c) jobsite safety
   d) public safety

6. List and describe the correct procedures to be used when tacking pipe ready for the welder.

7. Interpret CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* pertaining to the installation of welded ferrous gas piping and fittings in both indoor and outdoor, above ground and below ground pipe installations.

Tube and tubing ..... *3 Hours*

1. List and describe types and materials used for ferrous and non-ferrous tube and tubing used in the gasfitting trade, and state the application of each material.
   a) steel
   b) copper
   c) aluminum

2. List and describe grades of tube and tubing available.

3. Describe pressure ratings of different tube and tubing grades.

4. Recognize and state tube and tubing sizes.

5. Recognize and describe different protective coatings applied to ferrous tube and tubing.

6. State the requirements for cathodic protection of underground gas pipe.

7. Recognize, name and size fittings used on tube and tubing.

8. Describe pressure ratings of tube and tubing fittings.

9. Interpret CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* pertaining to tube and tubing and fittings used on gas installations.

10. List and describe correct jointing processes for tube and tubing:
    a) flared
    b) compression
    c) soldering
    d) brazing

11. List and describe the correct tools needed for joining tube and tubing using flared fittings.

12. List and describe the correct procedures to use when flaring tube or tubing using hand tools.

13. Describe how to flare tube and tubing using hand tools.

14. Interpret CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* pertaining to flared tube and tubing fittings used on gas installations.

15. List and describe the correct tools needed for making compression pipe, tube and tubing joints.

16. List and describe correct procedures to use when making compression joints on pipe, tube and tubing.

17. Make compression joints on pipe tube and tubing.

18. Interpret CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* pertaining to compression joints on pipe, tube and tubing fittings used on gas installations.

Soldering and brazing ..... *4 Hours*

1. Recognize, name and size soldered and brazed tube and tubing fittings, and state where each would be used.

2. Describe pressure ratings of soldered and brazed fittings.

3. List and describe correct fabrication processes for soldered and brazed tube and tubing jointing:
   a) measure
   b) mark
   c) cut
   d) ream
   e) clean
   f) flux
   g) heat
   h) solder

4. List and describe the correct tools and welding equipment needed for assembling a soldered or brazed joint on tube or tubing.

5. List and describe correct procedures to use when soldering or brazing tube or tubing.

Solder or braze tube or tubing

1. List and describe the correct installation procedures to be used for the installation of tube and tubing for gas supply.

2. Describe the correct safety practices to be used when soldering or brazing tube and tubing:
   a) personal safety
   b) personnel safety
   c) jobsite safety
   d) public safety

3. Interpret CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* pertaining to the installation of tube and tubing for gas supply in indoor outdoor, above ground and below ground installations.

Hoses ..... *2 Hours*

1. List and describe types and materials to be used for gas hose in the gasfitting trade.

2. Describe pressure ratings of different gas hose.

3. Recognize and state hose sizes.

4. Interpret CSA B 149.1 Gas Codes and Alberta Safety Services Plumbing and Gas Standards pertaining to gas hose.

5. Recognize, name and size gas hose fittings used.

6. Describe pressure ratings of hose fittings.

7. Interpret CSA B 149.1 Gas Codes and Alberta Safety Services Plumbing and Gas Standards pertaining hose fittings used.

8. Interpret CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* pertaining to the installation of hose for gas supplies.

Valves ..... *4 Hours*

1. Recognize and name type of valve:
   a) plug valves
   b) eccentric valves
   c) gate valves
   d) globe valves
   e) check valves
   f) ball valves

2. Describe features of valve.

3. List and describe pressure markings and ratings of various valves.

4. List and describe correct maintenance procedures for lubricating plug valves:
   a) standard plug valves
   b) lubricated plug valves
   c) appliance control cocks
   d) plug valves built in to automatic controls
   e) range burner valves

5. List and describe correct maintenance procedures for gate and globe valves:
   a) propane cylinder and tank valves
   b) hot and cold water and steam control valves

6. Interpret CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* pertaining to the installation of all types of valves for gas applications.

Hangers..... *5 Hours*

1. Recognize and name pipe, tube and tubing hangers used in the gasfitting industry.

2. State uses of different hangers.

3. List and describe protective materials applied to hangers.

4. State the reasons for using protective coatings on hangers with reference to corrosion and electrolysis.

5. List the maximum distances between hangers on different sizes of gas line, in both SI and imperial units.

6. Recognize and name the different fasteners and inserts used to secure pipe, tube and tubing hangers.

7. Describe correct fasteners and inserts installation techniques.

8. List and describe the correct installation processes for pipe, tube and tubing hangers and supports.

9. List and describe the correct tools needed when installing hangers.

10. Calculate hanger spacing.

11. Calculate pipe grades.

12. Calculate hanger rod lengths needed to achieve pipe grades.

13. Install hangers using correct fasteners and inserts.

14. Interpret CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* pertaining to the installation of all types of hangers for supporting pipe tube and tubing used for gas applications for both indoor and outdoor installations.

SECTION SIX: ..... GASFITTING THEORY AND CODE INTERPRETATION ..... 40 HOURS

A. Introduction to the *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* ..... 10 Hours

1. List and describe the regulations contained in the scope section of the CSA B 149.1 Gas Codes.

2. Use the definitions section of the CSA B 149.1 Gas Codes to obtain the definitions of common terms used in the Gasfitting trade.

3. Use the abbreviations section of the CSA B 149.1 Gas Codes to obtain the definitions of common abbreviations used in the Gasfitting trade

4. State the regulations contained in the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* pertaining to the general requirements for the trade of gasfitting:
   a) approval of appliances and equipment
   b) basic requirements for the field construction of appliances CSA B149.3
   c) responsibilities of installer
   d) hazardous locations
   e) checking gas leaks
   f) smoking
   g) deviation and postponement
   h) isolation of safety devices
   i) meter installations
   j) regulator installations

5. Residential appliances:
   a) suitability for use
   b) locations
   c) appliance connection
   d) appliance clearances
   e) accessibility
   f) responsibility of the installer
   g) damaged and used appliances
   h) conversions
   i) shut off valves
   j) electrical components
   k) appliances in garages
   l) outdoor installations

6. State the regulations contained in the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* pertaining to the installation requirements for appliances and equipment.

7. Residential appliance installations:
   a) clothes dryers
   b) direct vent appliances
   c) domestic ranges
   d) fireplaces
   e) furnaces
   f) hot water tanks
   g) make-up air heaters
   h) storage water heaters
   i) unit heaters

8. State the regulations contained in the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* pertaining to the installation requirements for appliances and equipment.

9. List residential appliances in the four categories of appliances.

10. Air requirements:
    a) general requirements
    b) appliances located in confined spaces
    c) appliances located in unconfined spaces

11. State the regulations contained in the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* pertaining to the air required for appliances for combustion, ventilation and flue gas dilution.

12. List and describe Depressurization Limits for Buildings for buildings and determine if pressure induced drafthood spillage is probable (In accordance with ABC requirements).

13. State the regulations contained in the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* pertaining to the installation of vents and chimneys for gas burning appliances.

14. State and list each of the "vented appliance categories" venting requirements for residential appliances.

15. State the regulations contained in the CSA B 149 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* pertaining to the installation, testing and purging of piping, tube, tubing, hose, plastic and the associated fittings for gasfitting.

B. Introduction to Venting ..... 10 Hours

1. Define common vents.

2. State the application and temperature rating for metal manufactured vents.

3. Identify and name common types of draft hood:
   a) vertical
   b) horizontal
   c) horizontal to vertical
   d) vertical to horizontal

4. State applications of each type of draft hood.

5. State installation procedures for different types of draft hood.

6. List the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* pertaining to location and installation of draft hoods.

7. Identify and state the size of high altitude and low altitude flue collars.

8. List and describe the acceptable materials for vent connectors.

9. State temperature limitations for different materials used for vent connectors.

10. List and describe installation procedures for vent connectors.

11. List the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* pertaining to vent connector installations and power venting.

12. State from memory, minimum allowable clearances for vent connectors from combustible materials, without using protective materials.

13. Use the tables of clearances for different protective materials given in the CSA B 149.1 Gas Codes to determine reductions of clearances that can be safely achieved for vent connectors.

14. Size vent connectors using the minimum size rules.

15. Size gas vent connectors from B 149.1.1 Gas Codes and Alberta Safety Services Plumbing and Gas Standards.

16. List and describe the various vents used for gas appliances:
    a) metal
    b) plastic

17. State application temperatures for each type of vent.

18. State the materials used in the manufacture of each type of vent.

19. List and describe correct installation procedures for gas vents.

20. State minimum clearances permitted for gas vents from combustible materials.

21. List and describe correct location and techniques for terminating gas vents above roofs.

22. Calculate height of gas vent above sloping roofs to achieve minimum clearances above roof.

23. State the minimum size for gas vents for single appliance vents.

24. Size gas vents for multiple appliances venting installation using alternate sizing methods.

25. List the B 149.1.1 and 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* pertaining to vent connector installations.

26. List and describe the various direct vents used for gas appliances.

27. Describe operating principles of direct vented appliances.

28. List and describe the installation procedures for venting direct vented appliances.

29. State minimum clearances and termination practices for direct vented appliances.

30. List the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* pertaining to direct vented appliances.

31. List the CSA B 149.1 Gas Codes and Alberta Safety Services Plumbing and Gas Standards pertaining to gas vent installations.

32. List the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* pertaining to barometric draft controls.

C. Pressure Regulators ..... 8 Hours

1. List and describe the types of pressure regulators used on gas supplies and appliances:
   a) propane first stage
   b) propane second stage
   c) natural gas service line
   d) appliance regulators

2. Describe the operating principles of different types of pressure regulators.

3. State applications of different types of pressure regulators.

4. List and describe types and purposes of different pressure regulator internal controls:
   a) pressure relief valves
   b) low pressure cut off valves
   c) high pressure cut off valves

5. List and describe types and purposes of different pressure regulator vent attachments:
   a) vent lines
   b) vent limiting orifices
   c) surge arrestors

6. Use regulator sizing tables to determine flow rates and pressure drop across regulators.

7. Size pressure regulators from design charts and tables.

8. List and describe correct installation procedures for all types of pressure regulators including PFM.

9. List dangers of not taking a gas pressure reading prior to the connection of appliances.

10. List and describe the correct use and installation of different pressure regulator internal controls:
    a) pressure relief valves
    b) low pressure cut off valves
    c) high pressure cut off valves

11. List and describe the correct use and installation of different pressure regulator external vent attachments:
    a) vent lines
    b) vent limiting orifices
    c) surge arrestors

12. List and describe the regulations contained in the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* pertaining to the installation of gas pressure regulators.

13. List and describe maintenance procedures for different types of pressure regulators and attachments.

14. Perform routine maintenance on different styles of regulators and attachments.

15. List problems and describe correction procedures for common pressure regulator problems.

16. List and describe the causes of internal and external freezups on pressure regulators.

17. List and describe preventative procedures to minimize internal and external freezups on all types of pressure regulators.

18. Perform diagnostic maintenance to determine customer complaints involving pressure regulators.

D. Gas and Liquid Meters ..... 2 Hours

1. List and describe the types of gas meters:
   a) low pressure propane meters
   b) low pressure natural gas
   c) propane liquid meter
   d) pressure factor metering

2. Describe operating principles of positive displacement gas meters.

3. List and describe the correct installation procedures for gas meters:
   a) low pressure propane meters
   b) low pressure natural gas

4. State the possible problems in not checking meter capacity when installing additional appliances to an existing service.

5. Identify meter dials in both SI and imperial units:
   a) index dials
   b) test dials

6. Read gas meter indexes in both SI and imperial units:
   a) clock style dials
   b) odometer style dials

7. Use test dials to determine gas consumption of gas appliances in both SI and imperial units:
   a) low pressure propane
   b) low pressure natural gas

8. Use heating values of gases to convert clocked volumes into heat flow rates in both SI and imperial units.

E. Residential Gas, Electrical and Electronic Controls ..... 10 Hours

1. Identify and name control:
   a) gas cocks
   b) rod and tube thermostats
   c) liquid bulb thermostats

2. Describe operating principles of control.

3. List and describe the correct installation techniques for control.

4. Set and adjust calibration of control where appropriate.

5. Set and adjust bypass on control where appropriate.

6. Perform thermocouple analysis on control as appropriate.

7. Perform routine maintenance on control.

8. Perform diagnostic maintenance; determine customer service problems and correct where necessary.

9. Test control for gas leaks and valve let-by.

10. Identify and name control:
    a) safety valves
    b) safety switches
    c) limit switches
    d) fan switches
    e) room thermostats
    f) operating gas valves
    g) solenoid valves

11. Describe operating principles of control.

12. Determine voltage, amperage and wattage of control.

13. Match voltage, amperage and wattage of control to intended application:
    a) diaphragm gas valves
    b) redundant gas valves

14. Calculate switch volt-amperage rating needed in control circuit.

15. Match switch volt-amperage to intended application of control.

16. List and describe the correct installation techniques for control.

17. Set and adjust calibration of and operating set points on control where appropriate.

18. Perform thermocouple analysis on control as appropriate.

19. Perform routine maintenance on control.

20. Use electrical test instruments to measure voltage, amperage, resistance and continuity in electrical circuits and controls where appropriate.

21. Perform diagnostic maintenance, determine customer service problems and correct where necessary.

22. Test control for gas leaks and valve let-by.

SECTION SEVEN: ..... GAS SHOP AND LAB WORK ..... 66 HOURS

A. Safe Use of Tools ..... 6 Hours

1. Demonstrate correct and safe use of all hand and power tools used by a gasfitter.

2. Replace worn or defective parts of hand and power tools as necessary.

3. Sharpen and dress cutting tools where necessary.

4. List and describe workmanship, safety and correct operational procedures associated with hand and power tools.

5. Demonstrate correct and safe use of all explosive activated tools used by a gasfitter.

6. Replace worn or defective parts of explosive activated tools as necessary.

7. List and describe workmanship, safety and correct operational procedures associated with explosive activated tools.

B. Hot Tapping ..... 3 Hours

1. Secure work area to a safe condition for hot tapping operations.
2. Use tools and equipment to perform hot tapping operations.
3. Correctly maintain tools and equipment.
4. Correctly and safely perform hot tapping operations.
5. Correctly and safely monitor and respond to combustible gases in the atmosphere.
6. Test hot taps and leave installation in safe operating condition.

C. Pipe Jointing Techniques ..... 15 Hours

Threaded pipe

1. Identify by name, grade, size and material the pipes used for conveying gas.
2. Identify by name, grade, size and material the threaded pipefittings used for gasfitting.
3. Identify by name, grade, size and material the tools used for threading pipe in gasfitting.
4. Use hand and power tools to thread pipe following all safety procedures.
5. Cut and thread pipe to required dimensions using correct processes.
6. Assemble and test threaded pipe joints using correct processes.
7. Leak test threaded pipe joints in accordance with the regulations given in the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards.*

Welded pipe

1. Identify by name, grade, size and material the pipes used for conveying gas.
2. Identify by name, grade, size and material the welded pipefittings used for gasfitting.
3. Identify by name, grade, size and material the tools used for welding pipe in gasfitting.
4. Use hand and power tools to bevel pipe ready for tacking and welding following all safety procedures.
5. Cut and bevel pipe to required dimensions using correct processes.
6. Assemble welded pipe to the tack stage using correct processes.
7. Tag and identify welded pipe in accordance with the regulations given in the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards.*

Soft soldered joints

1. Identify by name, grade, size and material the tube used for soft soldered applications in the gasfitting trade.
2. Identify by name, grade, size and material the soft soldered fittings used for gasfitting applications.

3. Identify by name, grade, size and material the tools used for soft soldering in gasfitting.

4. Use hand and power tools to prepare and assemble soft soldered joints in a correct and safe manner following all safety procedures.

5. Cut, prepare and flux soft solder joints to required dimensions using correct processes.

6. Assemble and soft solder joints using correct processes.

7. Leak test soft soldered joints in accordance with the regulations and standards.

Brazed joints

1. Identify by name, grade, size and material the tube used for brazed soldered joints in the gasfitting trade.

2. Identify by name, grade, size and material the hard soldered fittings used for gasfitting applications.

3. Identify by name, grade, size and material the tools used for brazed joints used in gasfitting.

4. Use hand and power tools to prepare and assemble brazed joints following all safety procedures.

5. Cut, prepare, and flux brazed joints to required dimensions using correct processes.

6. Assemble and braze joints using correct processes.

7. Leak test brazed joints in accordance with the regulations given in the CSA B 149.1 Gas Codes and with the regulations in *Alberta Safety Services Plumbing and Gas Standards.*

Flared joints and double flared joints

1. Identify by name, grade, size and material the tube used for flared joints in the gasfitting trade:
   a) aluminum
   b) copper tube
   c) copper tubing

2. Identify by name, grade, size and material the flared joint fittings used for gasfitting applications.

3. Identify by name, grade, size and material the tools used for flared joints in gasfitting.

4. Cut, prepare, and flare tube and tubing required dimensions using correct processes.

5. Assemble and tighten flared joints using correct procedures.

6. Leak test flared joints in accordance with the regulations given in the CSA B 149.1 Gas Codes and with the regulations in *Alberta Safety Services Plumbing and Gas Standards.*

Approved O-ring compression joints:

1. Identify by name, grade, size and material the tube used for O-ring joints in the gasfitting trade.

2. Identify by name, grade, size and material the O-ring joint fittings used for gasfitting applications.
   a) Aluminum
   b) copper tube
   c) copper tubing

3. Identify by name, grade, size and material the tools used for O-ring joints in gasfitting.

4. Cut, prepare, and join tube and tubing to required dimensions using correct processes.

5. Assemble and tighten O-ring joints using correct procedures.

6. Leak test O-ring joints in accordance with the regulations given in the CSA B 149.1 Gas Codes and with the regulations in *Alberta Safety Services Plumbing and Gas Standards*.

D. Pipe, Tube and Tubing Cold Bending..... 4 Hours

1. Identify by name, grade, size and material the pipe, tube and tubing used for bending purposes in the gasfitting trade:
   a) aluminum
   b) copper
   c) steel

2. Identify by name, grade and size the tools used for pipe, tube and tubing bending in gasfitting.

3. Use hand tools to bend copper tube and tubing to required pattern and dimensions using specific bends following all safety procedures.

4. Use hand tools to bend copper tube and tubing to make offsets.

5. Use hand tools to bend copper tube and tubing to prescribed dimensions.

6. State regulations in the CSA B 149.1 Gas Codes relating to the use of bent pipe, tube and tubing in the gasfitting trade.

E. Use of Pressure Gauges and Manometers ..... 3 Hours

1. Identify types of manometers and pressure gauges:
   a) mechanical gauges
   b) direct reading manometers
   c) indirect reading manometers

2. Correctly fill water filled manometers.

3. Identify mercury filled manometers.

4. Read water filled direct reading manometers graduated in both SI and imperial units.

5. Read water filled indirect reading manometers graduated both in SI and imperial units.

6. Measure standing pressure in gas lines in both SI and imperial measurement units.

7. Measure operating pressures in gas lines in both SI and imperial measurement units.

8. Measure differential pressure in gas lines in both SI and imperial measurement units.

9. Measure manifold pressures on gas appliances in both SI and imperial measurement units.

Manufacturer's rating plates

1. Read and interpret gas appliance rating plates.

2. Check appliance manifold pressure against manufacturer's appliance rating plate.

3. Describe the corrective measures to be performed when appliance gas pressure does not match manufacturer's specifications.

Pressure regulators

1. Adjust pressure regulators:
   a) natural gas service line
   b) propane first stage
   c) propane second stage
   d) appliance

2. Diagnose pressure related faults on regulators:
   a) lock-up pressure
   b) pressure creep
   c) internal freeze-up
   d) external freeze-up
   e) pressure oscillation

3. Diagnose pressure related faults on gas lines:
   a) partial stoppage
   b) liquid in gas lines
   c) incorrectly sized gas lines

4. State the maximum allowable pressure drop across low-pressure gas lines in both SI and imperial units.

5. Leak test at low pressure.

6. Leak test hidden gas lines on gas appliances.

7. Test for valve let-by.

8. State regulations in the CSA B 149.1 Gas Codes relating to testing gas supplies for leaks using water manometers.

F. Meter Reading and Clocking ..... 3 Hours

1. Read clock type indexes in both SI and imperial units.

2. Read odometer style indexes in both SI and imperial units.

3. Recognize meter test dial.

4. Determine the capacity of meter test dial in both SI and imperial units.

5. Clock gas consumption rates in both SI and imperial volume units.

6. Convert volume consumptions into heat flow consumptions.

7. Read and interpret the manufacturer's appliance rating plates.

8. Check gas consumption rates of appliances to determine if gas consumption is correct.

9. List and describe the corrective measures to be adopted when gas consumption rates of appliances do not match manufacturer's specification.

G. Thermocouple Analysis ..... 3 Hours

1. Correctly perform diagnostic tests on a thermocouple and its safety control system:
   a) open circuit test
   b) closed circuit test
   c) response time test
   d) drop out point test
   e) turn down test
   f) safety shut down test

2. List and perform corrective procedures to be adopted when a thermocouple analysis reveals faults.

3. Replace faulty equipment where appropriate:
   a) thermocouples
   b) power units
   c) gas valves
   d) safety switches
   e) pilots

4. Test gas supply to pilots and safety controls for leaks.

5. Repair leaks where found.

H. Burner Adjustments ..... 3 Hours

1. Adjust orifices for correct gas being burnt.

2. Adjust orifices for correct gas consumption and pressures as specified by the appliance manufacturer.

3. Test gas supply to orifices and appliance manifolds for leaks.

4. Repair leaks where found.

5. Adjust the primary air shutters to give correct flame pattern or characteristics for specific burner applications:
   a) oxidizing flames
   b) neutral flames
   c) carbonizing flames

6. Adjust the secondary air dampers where appropriate, to give correct flame pattern inside a combustion chamber.

I. Drilling and Sizing Orifices ..... 4 Hours

1. Use orifice sizing charts to determine orifice sizes for specific gas consumptions and pressures in both SI and imperial units.

2. Convert orifice sized to drill sizes for hand drilling gas appliance orifices.

3. Select correct type and style of orifice for burner.

4. Drill orifice to correct size using appropriate methods.

5. Install and leak test newly drilled orifice.

6. Repair leaks where found.

7. Measure and adjust manifold pressure where necessary.

8. Clock meter to determine accuracy of orifice drilling.

9. Apply appropriate regulations contained in the B 149.1.1 and B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* pertaining to the sizing, drilling and installation of gas orifices.

J. Residential Appliance Gas Controls..... 22 Hours

1. Identify gas controls.
   a) gas control cocks
   b) oven thermostats
   c) hotplate thermostats
   d) hot water tank thermostats
   e) pressure regulators

2. Perform routine maintenance on gas controls.

3. Perform diagnostic procedures to determine reasons behind customer complaints.

4. Set, adjust and calibrate controls where necessary.

5. Install new equipment where necessary.

6. Leak test controls and repair gas leaks where found.

7. List and describe approved manual shut-off valves as listed in B 149 gas codes including those used on appliance controls.

8. Check gas cocks for valve let-by.

9. Describe lubricating procedures.

10. Repair valve let-by where necessary.

11. Identify electrical and electronic controls used on gas appliances and equipment:
    a) safety valves
    b) safety switches
    c) operating gas valves
       i) solenoid valves
       ii) diaphragm valves
    d) room thermostats
       i) millivolt
       ii) extra low voltage
    e) furnace fan switches
    f) furnace limit controls

12. Perform routine maintenance on electrically and electronically operated gas controls and equipment.

13. Perform diagnostic procedures to determine reasons for customer complaints.

14. Set, adjust and calibrate controls where necessary.

15. Correctly size new equipment where necessary.

16. Install new equipment where necessary.

17. Wire controls where necessary.

18. Wire series circuits.

19. Wire parallel circuits.

20. Wire gas appliance controls circuits for gas furnaces, gas hot water boilers and steam boilers, unit heaters, space heaters and other domestic applications:
    a) thermopile safety hook-up using safety valves
    b) thermopile safe hook-up using safety switches
    c) thermopile 100% safety using safety valves
    d) thermopile 100% safety using safety switches
    e) thermocouple safe hook-up using safety valves
    f) thermocouple safe hook-up using safety switches
    g) thermocouple 100% safety using safety valves
    h) thermocouple 100% safety using safety switches

21. Use electrical test meters to test for:
    a) voltage and millivolts
    b) resistance
    c) continuity
    d) amperage

22. Wire and test electronic controls.

23. Identify residential mid and high efficiency gas fired heating appliances.

24. List and describe the basic differences between all categories of gas fired appliances.

25. Explain venting and combustion air requirements for all categories of gas fired appliances.

SECOND PERIOD TECHNICAL TRAINING

GASFITTER TRADE
COURSE OUTLINE

Residential/Introduction to Commercial up to 400 MBH

SECTION ONE: ..... MATHEMATICS FOR GASFITTER ..... 22 HOURS

A. Trade Mathematics ..... 6 Hours

1. Calculate areas, volumes and capacities in both SI and imperial units of tanks and cylinders.
2. Calculate equal spread offsets.
3. Calculate cut lengths for threaded pipe.
4. Calculate cut lengths for welded pipe.

B. Trade Specific Mathematics ..... 10 Hours

1. Calculate areas of vents.
2. Calculate free areas of air supply ducts in both SI and imperial units.
3. Calculate free areas of air supply grills in both SI and imperial units.
4. Calculate mass filling densities of propane cylinders in both SI and imperial units, at standard temperature.
5. Calculate liquid volume filling densities of propane tanks at various filling temperatures in both SI and imperial units.
6. Calculate propane vaporization rate from propane cylinders and tanks at various ambient temperatures in both SI and imperial units.
7. Calculate pipe elevations, cover, invert and grade in both SI and imperial units.

C. Introduction to Computers ..... 6 Hours

1. State the use of computers in the trade.
2. Use basic computer commands.
3. Introduction to the Internet.
4. Introduction to heat loss calculation.

SECTION TWO: BLUEPRINT READING FOR GASFITTING ..... 16 HOURS

A. Residential and Commercial Blueprints ..... 10 Hours

1. Read residential and commercial blueprints in both SI and metric units.
   a) architectural
   b) structural
   c) mechanical
2. Identify gas appliances and equipment to be installed.
3. Identify the correct location of equipment to be installed.
4. Determine the correct pipe locations for gas lines.
5. Analyze the proposed installation for service conflicts.
6. Determine engineer's sizes for gas lines, flues, vents, chimneys and other ancillary equipment to be installed.
7. Interpret correct scale and dimensions.
8. Correctly interpret cutting plane lines and extension lines.
9. Recognize and interpret symbols and abbreviations for residential and commercial systems up to 400 MBH.
10. Determine heat loss for standard construction.

B. Architectural Specification ..... 3 Hours

1. Read and interpret architectural specifications as they apply to gasfitting.
2. Read and interpret architectural specifications as they apply to gasfitting residential and commercial applications up to 400 MBH.

C. Mechanical Specifications ..... 3 Hours

1. Read and interpret mechanical specifications as they apply to gasfitting.
2. Read and interpret mechanical specifications as they apply to gasfitting residential and commercial applications up to 400 MBH.

SECTION THREE: GASFITTING THEORY AND CODE INTERPRETATION ..... 70 HOURS

A. Residential and Commercial Gas Pipe Installation ..... 12 Hours

1. Explain the regulations for the installation of residential and commercial gas supply piping and equipment up to 400 MBH given in the *Gas Codes and Alberta Safety Services Plumbing and Gas Standards.*
2. Calculate hanger spacing and requirements for different sizes of gas lines and describe labeling requirements.

3. State the regulations in the Gas Codes and Alberta Safety Services Plumbing and Gas Standards that relate to:
   a) testing gas installations for leaks;
   b) gas lines including secondary gas lines;
   c) finishing piping;
   d) appliance piping and manifolds.

4. Test gas lines for leaks and repair leaks where necessary.

5. Demonstrate the various approved methods of testing for gas leaks.

6. Test valves and controls for valve let-by, and repair where necessary.

7. Describe the correct techniques for safely purging gas lines:
   a) replacing air with gas
   b) replacing gas with inerts

8. Purge gas lines correctly.

9. State the maximum pressure drop allowed for residential and commercial installations.

10. List and describe the correct methods for measuring gas pressure:
    a) standing pressure
    b) operating pressure
    c) manifold pressure
    d) differential
    e) pressure drop

11. List and describe the correct methods for adjusting gas line pressures:
    a) propane
    b) natural gas

12. List and describe the correct methods for adjusting gas appliance manifold pressures:
    a) propane
    b) natural gas

13. List and describe the types of approved hose, flexible metallic hose and connectors.

14. State the regulations in the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* stating the requirements for hose, flexible metallic hose and connectors.

15. List and explain installation requirements for hose, flexible metallic hose and connectors.

B. Two Pound Gas (14 kPa) ..... 2 Hours

1. List and describe applications of 2 psi gas.

2. Code requirements

3. Piping materials and joining methods

4. Typical installation

5. Hanging and labeling

6. Leak testing and purging

7. Explain the regulation pertaining to the installation of 2 psi gas supply piping and equipment given in the *Gas Codes and Alberta Safety Services Plumbing and Gas Standards.*

8. Calculate hanger spacing and requirements for different sizes of gas lines and describe labeling requirements.

9. State the regulations in the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards,* which relate to testing gas installations for leaks:
   a) high-pressure gas lines including secondary gas lines
   b) finishing piping
   c) appliance piping and manifolds

10. Describe procedures for testing gas lines for leaks.

11. List the approved methods of testing for gas leaks.

12. Describe the correct techniques for safely purging gas lines:
   a) replacing air with gas
   b) replacing gas with inerts

13. State codes regarding purging gas lines correctly.

14. State the maximum pressure drop allowed across a gas installation for:
   a) 14 inch (3.50 kPa);
   .b) 2 psig (14 kPa).

15. List and describe the correct methods for measuring gas pressure:
   a) standing pressure
   b) operating pressure
   c) manifold pressure
   d) differential
   e) pressure drop

16. List and describe the correct methods for adjusting gas line pressures:
   a) propane
   b) natural gas

17. List and describe the correct methods for adjusting gas appliance manifold pressures:
   a) propane
   b) natural gas

C. Residential and Commercial Gas Line Sizing..... 6 Hours

1. State the regulations related to gas line sizing contained in the CSA B 149.1.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards,* for minimum and maximum sizes of gas lines needed in gas installations up to 2 psi:
   a) natural gas – steel
   b) natural gas – copper
   c) propane gas – steel
   d) propane gas - copper

2. Ascertain layout of gas line in a building.

3. Determine the volume of gas consumed by appliances.

4. Determine volume of gas required to be delivered through each portion of the gas line.

5. Determine the length of the gas piping conveying gas.

6. Determine the quantity and types of fittings used in the gas installation.

7. Determine the type of gas being consumed.

8. State the regulations in the gas codes pertaining to gas pressures in buildings.

9. Locate the correct table to be used in the CSA B 149.1 Gas Codes or Alberta Safety Services Plumbing and Gas Standards.

10. Correctly size gas lines using a gas line sizing table.

11. Describe the approved methods of leak testing and gas detection.

D. Gas Line Installation ..... 6 Hours

1. Not more than three of the following gas fired appliances to be piped in the simulated gas line installation:
   a) boiler or furnace
   b) water heater and one of either
   c) clothes dryer
   d) stove
   e) fridge
   f) barbeque

2. Layout, size and sketch project with reference to blueprints, the regulations in the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards.*

3. Compile materials list for proposed gas line rough-in excluding finish piping.

4. Identify by name, grade, and size the material and pipes used for conveying gases.

5. Identify by name, grade, and size the material and threaded pipe fittings used for the installation.

6. Identify by name the tools used for threading pipe.

7. Install and hang the gas line using accepted practices and procedures outlined in CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* with special attention to:
   a) workmanship;
   b) correct sizing;
   c) correct hanger placement.

8. Follow correct safety practices using tools and ladders when installing gas piping with regard to:
   a) personal safety;
   b) personnel safety;
   c) jobsite safety;
   d) public safety.

9. Test the installation for leaks in accordance with the B 149.1.1 and B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards.*

10. Identify, explain and use appropriate equipment to monitor and test for the presence of gas in building.

E. Installation and Sizing of Venting Systems for Appliances up to 400 MBH ..... 18 Hours

1. State the regulations in the CSA B 149.1 Gas Codes, and Alberta Safety Services Plumbing and Gas Standards that relate to minimum and maximum vent sizes to be used in gas installations and that will over-rule gas vent sizes determined from sizing tables.

2. Correctly identify the type of construction where the appliance(s) is/are located.
3. State the regulations from the CSA B 149.1 Gas Codes and manufacturer's information.
4. Determine effective vent height.
5. Determine lateral length of vent connector.
6. Determine gas input of the appliance.
7. Identify correct sizing table in gas codes.
8. Use tables to determine correct vent size.
9. Determine effective vent height for two vented appliances.
10. Determine vertical rise of each appliance vent connector.
11. Determine capacity for each appliance vent connector.
12. Select the appropriate sizing table for sizing appliance vent connectors.
13. Use the appropriate sizing table to determine each vent individual connector size.
14. Select appropriate sizing table for sizing vent connectors from the gas codes.
15. Use the appropriate sizing table to determine proper vent size.
16. Use the tables of clearances for different protective materials given in the CSA B 149.1 Gas Codes to determine reductions of clearances that can be safely achieved for chimney connectors.
17. Use the appropriate sizing table to determine vent connector size.

Sizing natural draft chimneys

1. Explain regulations in the CSA B 149.1 Gas Codes and Alberta Plumbing and Gas Safety Bulletins that relate to minimum and maximum chimney sizes to be used in installations and that will over-rule chimney sizes determined from sizing tables.
2. Correctly identify the type of construction where the appliance(s) is/are located.
3. Determine effective chimney height.
4. Determine lateral length of vent connector.
5. Determine gas input of the appliance.
6. Identify the correct sizing table in gas codes.
7. Use tables to determine correct vent connector and chimney size.
8. State and use table for sizing individual vent connectors and individual chimney size.
9. Determine effective chimney height when sizing chimney for multiple appliances.
10. Determine the vertical rise of each vent connector.

11. Determine gas input for each appliance.

12. Select appropriate table for sizing each appliance vent connector.

13. Use appropriate table to determine each individual connector size.

14. Select appropriate table for chimney sizing from gas codes and size chimney accordingly.

15. Select the round to rectangular sizing table for chimneys from gas codes.

16. Determine the round equivalent of rectangular chimneys.

17. Determine the rectangular equivalent of round chimneys.

Direct vented flues

1. Correctly interpret the regulations in the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* that pertain to direct vented appliances.

2. Correctly identify the type of structure where the appliance(s) is/are located.

3. State the minimum permitted distances between direct-vented flue terminations and fresh air intakes into buildings.

4. State the minimum permitted distances between direct-vented flue terminations and gas meters, pressure regulators and other components.

5. Correctly interpret the regulations in the CSA B 149.1 Gas Codes, and vent tables, and Alberta Safety Services Plumbing and Gas Standards that pertain to fan assisted vents.

6. Identify and describe the operating principles of different types of thermal operated flue dampers.

7. List and describe the installation practices for thermal operated flue dampers.

8. Identify and describe the operating principles of different types of electrically operated flue dampers.

9. List and describe the installation practices for electrically operated flue dampers.

10. Correctly interpret regulations in the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* that pertain to flue dampers.

F. Combustion Air Requirements For Residential/Commercial Appliances Up To 400 MBH ..... 10 Hours

1. State the regulations in the CSA B 149.1 Gas Codes and, Alberta Safety Services Plumbing and Gas Standards that relate to air supply and air grill sizes for residential/commercial appliances up to 400 MBH.

2. Identify building type, envelope and construction where the appliance(s) is/are located.

3. Identify the category of appliance type of draft control.

4. Select appropriate table for the application.

5. Identify and name the different types of grills and louvers used for air supply.

6. State the required air grill sizing ratios for different applications.

7. State the correct method for sizing: grills, louvers, and air supply ducts.

8. Calculate the free area of grills and louvers allowing for restriction factors.

9. Calculate the size of grills and louvers needed for different applications.

10. Calculate the size of air supply ducts needed for different applications.

11. Calculate the air required for combustion, ventilation and flue gas dilution.

12. Calculate the free area of grills and louvers needed for different applications.

13. Calculate sizes of grills and louvers needed for different applications.

14. Calculate the size of air supply ducts needed for different applications.

G. Installation Requirements For Residential/Commercial Appliances Up To 400 MBH ..... 6 Hours

1. List and describe the categories of appliances and explain the impact on the installation requirements.

2. Explain the various types of building construction and explain how this impacts on installation requirements for common appliances under 400 MBH:
   a) boilers
   b) commercial appliances
   c) instantaneous water heaters
   d) direct fired make-up air heaters
   e) direct vent appliances
   f) fireplaces
   g furnaces
   h) infrared heaters
   i) pressure boosters
   j) radiant tube heaters
   k) ranges
   l) roof-top units
   m) unit heaters
   n) other appropriate appliances

3. List and explain the safety precautions to be used when installing gas appliances:
   a) personal safety
   b) jobsite safety
   c) public safety

4. List gas appliance approval agencies acceptable for gas appliances in the province of Alberta.

5. List and describe the altitude rating requirements for appliances installed in the province of Alberta.

6. Explain the regulation pertaining to the installation of specific gas appliances and equipment given in the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards.*

7. Identify rating plate requirements for specific appliances.

8. Describe correct site preparation for the appliance to be installed.

9. Explain the regulation pertaining to the installation of specific gas appliances and equipment given in the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards.*

10. Describe correct site preparation for the appliance to be installed.

11. Interpret manufacturer specifications and instructions regarding appliance installation.

12. State minimum clearances for appliances.

13. List and describe correct appliance testing and setup procedures following initial appliance installation.

14. List and describe how is manifold pressure measured.

15. List and describe how the gas meter clocked to determine the gas consumption to the appliance.

16. List and describe how to determine the correct orifice size from manifold pressure, clocked gas consumption and orifice sizing charts.

17. List and describe correct customer operation instructions to be given to the user by the installer before leaving the installation.

18. List and describe installer's responsibility relating to gas appliance installations.

H. Propane Cylinder Systems..... 10 Hours

1. Use B 149.2 Propane Code and Alberta Safety Services Plumbing and Gas Standards to locate and interpret correct cylinder location on customer's property.

2. Determine load factors when sizing cylinders for customers' applications.

3 List and describe the effects of temperature increase and decrease on the pressure of propane in the cylinder.

4. List and describe the effects the colour of a container has on the temperature of propane in cylinder.

5. List and describe the effects the colour of a cylinder has on the vaporization rate from the container.

6. List and describe the effects of filled capacity on the vaporization rate from a propane cylinder.

7. Calculate vaporization capacity of propane cylinders at various different temperatures, colours and filled capacities.

8. State minimum distances of propane cylinders from building openings, air intakes, doors, windows, flue terminations, drier, vents, etc.

9. List and describe installation procedures for propane cylinders.

10. Use B 149.2 Gas Code and Alberta Safety Services Plumbing and Gas Standards to locate and interpret regulations pertaining to the installation of propane cylinders on customer property.

11. List and describe routine maintenance to be undertaken to reduce fire hazards and other damage to propane cylinders.

12. List and describe the safety valves used on propane cylinders.

13. State discharge pressure for propane cylinder safety relief valves.

14. Use B 149.2 Gas Code and Alberta Safety Services Plumbing and Gas Standards to locate and interpret regulations pertaining to the installation of safety valves on propane cylinders.

15. State correct location of discharge outlets from safety relief valves.

16. Calculate the rate of discharge from safety relief valves.

17. List and describe the valves and accessories used on propane cylinders for vapor withdrawal applications.

18. Recognize and identify valves and accessories used on propane cylinders for vapor withdrawal applications.

19. Describe the characteristics and features of valves used for vapor withdrawal from propane cylinders.

20. List and describe the routine maintenance procedures required on valves and accessories used on propane cylinders for vapor withdrawal applications.

21. Size excess flow valves for vapor withdrawal.

22. List and describe the valves and accessories used on propane cylinders for liquid withdrawal applications.

23. Recognize and identify valves and accessories used on propane cylinders for liquid withdrawal from propane cylinders.

24. Describe the characteristics and features of valves used for liquid withdrawal from propane cylinders.

25. List and describe the routine maintenance procedures required on valves and accessories used on propane cylinders for liquid withdrawal applications.

26. Size excess flow valves for liquid withdrawal from cylinders.

27. List and describe the valves and accessories used on propane cylinders for filling applications.

28. Recognize and identify valves and accessories used on propane cylinder for cylinder filling.

29. Describe the characteristics and features of valves and accessories used for filling applications.

30. List and describe routine maintenance required on valves and accessories used on propane cylinders for filling applications.

31. Size excess flow valves for cylinder filling hoses.

32. State the correct filling density of customer propane storage cylinders at standard temperature.

33. Use the B 149.2 Propane Code to determine the correct filling density of customer propane storage cylinders at various temperatures.

34. Calculate the correct filling capacity of customer propane storage cylinders by mass in both SI and imperial units.

35. List and describe correct vehicle access, parking and preparation for dispensing propane from the bulk tank into a customer's propane storage cylinder at the company's premises.

36. List and describe correct transfer hose connections from the pump to a customer's propane storage cylinder for filling purposes.

37. List, describe and perform correctly the safety procedures used when transferring propane between bulk tank and customer's cylinder for filling purposes.

38. List and describe correct cylinder filling terminology.

39. List, describe and use correct safety procedures used to protect self, co-workers, public and jobsite from exposure to unsafe conditions and possible accidents during cylinder filling operations.

40. List, explain and perform with confidence, emergency procedures to be used in the event of an emergency occurring during a cylinder filling process.

SECTION FOUR: ..... ELECTRICAL THEORY ..... 72 HOURS

A. Electrical and Electronic Principles ..... 16 Hours

1. Identify magnetic fields and lines of force regarding magnetism.
2. Explain electromagnetism.
3. Describe electromagnet induction.
4. Describe self-induction in a coil.
5. Describe mutual induction in a coil.
6. List and describe the use of electromagnetism in gas controls.

Electricity

1. Describe the Electron theory.
2 Define and explain the meaning terms: amps, volts and ohms.
3. Define and explain the principles of direct current flow and alternating current flow of electricity.
4. Calculate Ohm's law in direct and alternating current flow.
5. Identify the electrical symbols used in gasfitting.
6. Describe the affects of low and high voltage.
7. Identify units of current measurement.
8. Define power (VA) and state how it is measured.
9. Define resistance and state how it is measured.
10. Define impedance and state how it is measured.
11. Relate current to power.
12 Relate resistance to power.
13. Describe conduction.
14. Describe rectification.

Types and gauges of electrical wires

1. State the materials used for electrical wiring to gas fired appliances.
2. Identify conductive properties of the materials.

3. State how the thickness of wire is measured and the application and rating of various wire gauges used in gasfitting.

Basic electronics

1. Describe the principles of resistors, diode, SCR, triac, transistors and thermistors and explain their use in gas-fired appliances.

2. Identify electronic circuit boards used in gas fired appliances.

3. Explain their use in gas-fired appliances up to 400 MBH.

4. Review basic safety when working with electricity including polarity check of local supply.

5. List and explain the safety precautions to be used when working with electricity:
   a) personal safety
   b) jobsite safety
   c) public safety

B. Wiring Diagrams ..... 18 Hours

1. Identify and describe Class 1 and Class 2 circuits electrical used in gas fired appliances and equipment up to 400 MBH.

2. Identify and state the basic operation of: series, parallel, series/parallel, series and parallel circuits.

3. List and explain types of wires used in gasfitting with reference to gauge, ampacity and application.

4. List and identify the various styles of wiring diagrams used for gas fired appliance controls and equipment up to 400 MBH:
   a) Ladder
   b) Schematic
   c) Connection
   d) Sequential

5. Identify and interpret schematic symbols used in wiring diagrams.

6. Sketch basic circuits complete with schematic symbols.
   a) Ladder
   b) Connection

7. Identify and interpret wiring diagrams for smaller basic gas fired appliances.

8. Identify and interpret wiring diagrams for gas fired appliances up to 400 MBH.

9. Sketch circuits complete with schematic symbols.

10. List and describe the sequence of operation of the circuits.

C. Non-Electrical, Electrical and Electronic Control Theory ..... 14 Hours

1. Explain the use of solids, liquids and gases used in the application of non-electrical controls.

2. Identify the use of bimetallic, thermal expansion of liquids and solids and thermo electrical effect used in non-electrical controls

3. List and identify controls that use the above principles and identify the controls using the correct schematic symbol.

4. State how these controls operate and how they are used in gas fired appliances and equipment up to 400 MBH.

5. Identify the four basic sections of control systems used in typical small gas fired appliance systems: operating controllers, limit and safety controllers, combustion safety controller and ignition control modules.

6. List and describe the various controls used in each of the four control systems and state their function.

7. Identify the components in wiring diagrams.

8. State the method of operation for operating controllers (various thermostats, operating aquastats, temperature and pressure switches, flow switches etc.)

9. List and describe location and installation procedure.

10. Describe the sequence of operation.

11. List and describe manufacturer and code requirements.

12. State the method of operation for limit and safety controllers: low water cutoff, high limit, operating limit, operating control, high limit pressure operated controls, pressure differential switches, flow switches, air proving switch, combination high limit/fan control switch, gas pressure switch, on time roll-out switches, spill switches, thermal fuse elements, etc.

13. List and describe location and installation procedure.

14. Describe the sequence of operation.

15. List and describe manufacturer and code requirements.

16. State the method of operation for combustion safety controls: milivolt systems, thermocouple, thermopile; flame rectification.

17. List and describe location and installation procedure.

18. Describe the sequence of operation.

19. List and describe manufacturer and code requirements.

20. State the method of operation for ignition control modules: standing pilot, intermittent pilot, direct spark ignition, hot surface ignition, etc.

21. List and describe location and installation procedure.

22. Sequence of operation.

23. List and describe manufacturer and code requirements.

D. Electrical Circuits and Systems ..... 16 Hours

1. Using a meter identify the following circuits:
   a) series
   b) parallel
   c) series/parallel
   d) series and parallel

2. Analyze and identify the common faults of the following equipment:
   a) relays
   b) time delay on/off
   c) momentary contact
   d) potential.

3. State the difference between types of relays used on gas fired appliances:
   a) single contact
   b) multi contact
   c) enclosed and open contact
   d) plug-in bases

4. Identify faulty overloads and fuses.

5. Explain the trouble shooting and service requirements for contacts and relays.

6. Determine voltage drops:
   a) 4-20 mAmp
   b) 0-10 volt DC
   c) floating (pulse) action
   d) 135 ohm

E. Transformers ..... 8 Hours

1. Identify transformers used for gas fired appliances and equipment.
   a) controls
   b) ignition

2 Identify symbols used for transformer in electrical diagrams.

3 Describe operating principles of transformers.

4. Determine voltage, amperage and wattage ratings of transformers.

5. Match voltampere (VA) rating and wattage of transformer to intended application.

6. Correctly size controls transformers for intended applications

7. State where and how transformers are installed.

8. Explain procedures and test meters and instrument to check operation of transformers.

9. List service problems and explain common faults.

10. Identify electrical test instruments to measure voltage, amperage, resistance and continuity in transformers.

11. Explain the use of the data resulting from testing transformers.

SECTION FIVE: ..... BURNERS AND COMBUSTION ..... 24 HOURS

A. Natural and Fan Assisted Draft Appliances ..... 12 Hours

1. List and describe the types of burners used in natural and power assisted draft appliances.
2. Describe the operation and function of each type of burner.
3. Explain the relationship between fan speed and volume delivered.
4. Explain the relationship between volume delivered and static pressure.
5. List and explain the selection requirements for a correctly sized fan.
6. List and describe the differences in fan location between natural, induced and forced.
7. List and describe procedures for converting an appliance from one gas to another.
8. List and describe regulations, applicable Gas Codes and Alberta Safety Services Plumbing and Gas Standards.
9. List and explain the safe light-up requirements for various burners.

B. Induced Burners and Combustion ..... 12 Hours

1. Specify the safe start-up procedure for various gas-fired appliances.
2. Define and describe an induced burner.
3. List and name the parts of induced burners.
4. State the applications of induced burners.
5. Describe the combustion process.
6. State the differences between induced and atmospheric burners.
7. Describe the flame characteristics.
8. List and describe components and accessories required for induced burners.
9. List the types of induced burners and accessories required for each.
10. List and explain the safe light-up requirements for various burners.
11. Explain pre-heat chimney procedures when required.

SECTION SIX: ..... GAS SHOP AND LAB WORK ..... 36 HOURS

A. Wiring Control Circuits ..... 12 Hours

1. Review generation of small value DC voltage: thermocouple and thermopile.

2. Test millivolt circuits.

3. Wire thermocouple/thermopile circuits for standard/ECO circuits.

4. Test pilot generator and measure millivolt drop through: valve coil, thermostat limit control and wire.

5. Wire series circuits.

6. Wire parallel circuits.

7. Wire combinations of series and parallel circuits.

8. Wire circuits for standard efficiency, mid efficiency and high efficiency appliances up to 400 MBH.

9. Wire circuits for gas controls and equipment using appropriate wiring diagram.

10. Wire millivoltage circuits and low voltage gas appliance circuits where appropriate.

11. Check wiring sequence for correct sequence of operation.

12. Follow all safety procedures and requirements. List and explain the safety precautions to be used when wiring control circuits.

B. Circuits, Control and Appliance Testing Up to 400 MBH..... 12 Hours

1. Specific controls
   a) aquastats
   b) diaphragm gas valves
   c) motor centrifugal start switches
   d) control module
   e) control board
   f) electronic ignition
   g) energy cut off devices
   h) fan switches
   i) flame rods
   j) flame safeguards
   k) flue dampers
   l) heat motor valves
   m) high limit switches
   n) hot surface ignition
   o) low limit switches
   p) piezo electric ignition
   q) pressure switches
   r) pump switches
   s) rectifying pilots
   t) room thermostats
   u) solenoid valves
   v) spark ignition
   w) thermal overload switches
   x) thermocouples
   y) thermopiles

2. Identify the differences between low, medium and high efficiency gas fired appliances.

3. Identify the wiring diagram and match it to the appliance control system.

4. Determine type of electrical or electronic controls.

5. Determine voltage, amperage and wattage of controls.

6. Match voltage, amperage and wattage of control to intended application.

7. Determine switch volt-amp rating needed by control circuit.

8. Match switch volt-amperage to intended application of control.

9. Set and adjust operating set points on control.

10. Diagnose service problems and correct faults.

11. Use test meters and instrument to check operation of equipment.

12. Measure operation of controls.

13. Replace faulty controls:
    a) warp switches
    b) zone dampers
    c) zone valves
    d) other appropriate controls

Ignition systems

1. Identify and Ignition systems:
    a) Direct Spark Ignition (D.S.I.)
    b) Hot Surface Ignition (H.S.I.)
    c) Intermittent Pilot Ignition (I.P.I.)

2 Describe the operating principles of each ignition system.

3. Measure operation of controls.

4. Replace faulty controls.

Transformers

1. Determine transformer ratings: voltage, amperage and wattage.

2. Match voltage, amperage and wattage of transformer to intended application.

3. Correctly size controls transformers for intended applications.

4. Use test meters and instrument to check operation of transformers.

5. Use electrical test instruments to measure voltage, amperage, resistance and continuity in transformers as necessary.

6. Install replacement transformers where necessary.

7. Use electrical lockout protection devices on circuit breakers when working with electrical controls equipment on gas appliances and controls.

8. Identify electrical test instruments for use on gas appliances and gas controls equipment.

9. Use range switch to select proper test instrument on multi-function meters.

10. Use electrical test instruments to measure amps, volts and ohms in typical gas appliances circuits and gas controls equipment.

11. Use electrical meters to determine continuity in wires, coils, circuits and other electronic and electrical components found on gas appliances and controls equipment.

12. Use test equipment to determine continuity in wires, coils, circuits and other components found on gas appliances and controls equipment.

13. List and explain the safety precautions to be used when servicing gas appliances:
    a) personal safety
    b) jobsite safety
    c) public safety

C. Troubleshooting Electrical Control Components Up to 400 MBH ..... 12 Hours

1. Using meter identify circuits:
    a) series
    b) parallel
    c) series/parallel
    d) series and parallel circuits

2. Analyze and identify the common faults associated with the following equipment:
    a) relays
    b) time delay on/off
    c) momentary contact
    d) potential.
    e) gas valves
    f) pilot stats
    g) gas safety controls

3. Identify faulty overloads and fuses.

4. Determine voltage drops:
    a) 4-20 mAmp
    b) 0-10 volt DC
    c) floating (pulse) action
    d) 135 ohm

THIRD PERIOD TECHNICAL TRAINING

GASFITTER TRADE
COURSE OUTLINE
High Efficiency Appliances and Controls Over 400 MBH Commercial/Industrial Application

SECTION ONE: ..... MATHEMATICS FOR GASFITTER ..... 8 HOURS

A. Mathematics for Gasfitter ..... 8 Hours

1. Describe the terms listed in #2.

2. Calculate the following electrical circuit factors:
   a) resistance
   b) current
   c) voltage
   d) voltage drops
   e) power factor
   f) power factor correction for motors
   g) impedance

SECTION TWO: ..... GASFITTING THEORY AND CODE INTERPRETATION ..... 40 HOURS

A. Commercial / Industrial, Combustion and Burners Over 400 MBH ..... 12 Hours

Combustion of gas ..... 2 Hours

1. Define and explain combustion terms associated with natural and propane gases burnt in appliances over 400 MBH.

2. Explain the basic processes of combustion of gas using primary and secondary air supply.

3. List the methods for introducing and controlling combustion air.

4. Use the properties of gases and combustion air/gas ratio to calculate total air needed for combustion.

5. List and describe the products of complete combustion of gas.

6. List and describe the dangers involved in allowing products of combustion to accumulate in the building.

7. List and describe the products of incomplete combustion of gas.

8. List and describe the dangers involved in allowing products of combustion to accumulate in the building including NOx and SOx.

9. Calculate the volume of excess air passing through combustion chamber for various proportions of excess air in the combustion chamber.

10. Explain CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* requirements for the supply of air for combustion, ventilation and flue gas dilution.

Combustion analysis ..... *6 Hours*

Combustion analysis theory

1. Explain factors relating to combustion analysis and efficiency in natural draft, low-pressure gas appliances over 400 MBH.

2. Explain primary air, secondary air, excess air, and dilution air adjustments made to gas burning appliances over 400 MBH.

3. Describe the correct methods for testing and adjusting combustion properties of gas appliances:
   a) manifold pressure
   b) gas consumption
   c) primary air
   d) secondary air
   e) excess air

4. Describe the correct method of using combustion analysis test kits to measure excess air in the appliance combustion chamber.

5. Use measured excess air ratio to calculate volume of excess air passing through the appliance combustion chamber.

6. Describe the correct method of using combustion analysis test kits to measure oxygen, carbon dioxide in the appliance combustion chamber.

7. Describe the correct method of measuring flue gas temperatures leaving appliance combustion chamber.

8. Use measured oxygen, carbon dioxide and flue gas temperature to determine the appliance efficiency in both SI and imperial units.

9. Demonstrate the correct use of combustion analysis test instruments to measure gas combustion processes.

10. Use combustion analysis processes to set low pressure, natural draft gas appliances over 400 MBH to optimum combustion efficiency.

Commercial/Industrial gas burners ..... *4 Hours*

1. Identify and describe the different designs of commercial gas burners serving appliances over 400 MBH:
   a) low pressure, natural draft
   b) low pressure, forced draft
   c) induced draft
   d) high pressure natural draft
   e) industrial, air blast
   f) industrial, pre-mixed
   g) pulse combustion

2. Identify and name the parts of gas burners.

3. Describe the applications of different burners used in natural and power assisted draft equipment for Commercial/Industrial applications:
   a) atmospheric
   b) mechanical-draft
   c) small port type (manifold)
   d) large-port burner (pressure type)
   e) tile-port burner (radiant)
   f) premix
   g) aspirator
   h) fan mix
   i) nozzle mixing
   j) excess air burner
   k) blast burner

4. Describe flame characteristics and adjustment procedures.

5. Explain CSA B 149.1 and B 149.3 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* requirements for the installation of gas burners and equipment.

B. Commercial/Industrial Appliance Installation and Servicing ..... 12 Hours

Appliance installation..... 6 Hours

1. Common appliances:
   a) air wall
   b) boilers
   c) commercial cooking appliances
   d) commercial clothes dryers
   e) construction heaters
   f) catalytic heaters
   g) domestic service water heaters
   h) direct /direct fired make-up air heaters
   i) incinerators
   j) industrial appliances
   k) pressure boosters
   l) roof-top units
   l) swimming pool heaters
   m) unit heaters (all types)
   n) other appropriate appliances

2. List and explain the safety precautions to be used when installing gas appliances:
   a) personal safety
   b) personnel safety
   c) jobsite safety

3. List gas appliance approval agencies acceptable for gas appliances in the province of Alberta.

4. List and describe the altitude rating requirements for appliances installed in the province of Alberta.

5. Explain the regulation pertaining to the installation of specific gas appliances and equipment given in the CSA B 149.1 and B149.3 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards.*

6. Describe correct site preparation for the appliance to be installed.

7. List and describe the correct appliance installation procedures.

8. List and describe correct venting requirements for appliance, where applicable.

9. List and describe correct provisions for air supply for combustion, ventilation and flue gas dilution for appliance installed.

10. List and describe correct appliance testing, start-up and setup procedures following initial appliance installation following B149.3 procedures.

11. Measure and adjust the manifold pressure in both SI and imperial units.

12. Describe how to clock the gas meter to determine the gas consumption to the appliance in both SI and imperials units.

13. Explain how check for the correct orifice size from manifold pressure, clocked gas consumption and correct use of the orifice sizing charts in both SI and imperial units.

14. Describe how to drill orifices to correct size where necessary.

15. List and describe the use combustion analysis processes to set gas appliances to optimum combustion efficiency.

16. Explain how to test and set appliance operating controls and all safety controls correctly for proper and safe operation of appliance.

17. List and describe correct customer operation instructions to be given to the user by the installer before leaving the installation.

18. List and describe installer's responsibility pertaining to gas appliance installations.

Commercial appliance servicing..... 6 Hours

1. Common appliances:
   a) boilers
   b) commercial appliances
   c) commercial clothes dryers
   d) construction heaters
   e) decorative appliances
   f) demand water heaters
   g) direct fired make-up air heaters
   h) direct vent appliances
   i) fireplaces
   j) furnaces (over 400 MBH)
   k) incinerators
   l) industrial appliances
   m) infrared heaters
   n) pressure boosters
   o) radiant tube heaters
   p) ranges

2. Measure, and adjust manifold pressure in both SI and imperial units.

3. Clock gas meters to determine the gas consumption of appliances in both SI and imperial units.

4. Describe how to determine the correct orifice size from manifold pressure, clocked gas consumption and orifice sizing charts in both SI and imperial unit.

5. Define how to size orifices to correct size where necessary.

6. List and describe correct routine maintenance required for typical appliances.

7. Perform routine maintenance on each appliance.

8. Identify how to test and set appliance operating controls and all safety controls correctly for proper and safe operation of appliance:
   a) refrigerators
   b) roof-top units
   c) swimming pool heaters
   d) unit heaters (all types)
   e) other appropriate appliances

9. Describe use of test instruments for diagnosis of appliance faults.

10. Identify how to troubleshoot and diagnose typical appliance service problems.

11. Describe how to use combustion analysis processes to set gas appliances to optimum combustion efficiency.

C. Commercial/Industrial Appliance Flues, Vents and Chimneys (400 MBH and over)..... 6 Hours

Principles of flues ..... 2 Hours

1. Explain the regulation pertaining to the installation of gas flues vents and chimneys given in the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards*:
   a) masonry chimneys
   b) metal manufactured chimneys
   c) power vents
   d) engineered systems

2. State the regulations in the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* that relate to minimum and maximum flue sizes to be used in installations and that will over-rule gas flue sizes determine from sizing tables.

3. State the venting requirements for the for "vented appliances categories".

4. State the regulations in the B 149.1*Gas Codes and Alberta Safety Services Plumbing and Gas Standards* that pertain to materials to be used for flues, vents and chimneys for gas burning appliances and combination dual fuel appliances.

5. Explain the details of multi-storey venting.

6. State code requirements for multi-storey venting.

Vent and chimney connectors ..... 1 Hour

1. Code interpretation:
   a) single wall vent connectors
   b) double wall vent
   c) connectors
   d) engineered systems

2. Explain the regulation pertaining to the installation of vent and chimney connectors given in the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards*.

3. State the regulations in the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* that relate to minimum vent and chimney connector sizes.

4. State the regulations in the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* that pertain to materials to be used for vent and chimney connectors for gas burning appliances and combination dual fuel appliances.

Barometric draft controls ..... *1 Hour*

1. Explain the regulation pertaining to the installation of barometric draft controls for dual fuel and gas appliances given in the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards.*

2. State the regulations in the CSA B 149.1 Gas Codes and Alberta Safety Services Plumbing and Gas Standards that relate to minimum selecting and sizing barometric draft controls.

3. State the regulations in the CSA B 149.1 Gas Codes and Alberta Safety Services Plumbing and Gas Standards that pertain to the installation of both single and double acting barometric draft controls on dual fuel and gas burning appliances.

4. Explain correctly sizing and installation requirements for single and double acting barometric draft controls.

5. Explain how to adjust barometric draft controls to provide the appropriate draft in the flue.

6. Describe how to use barometric draft gauges.

Power assisted vents ..... *1 Hour*

1. Correctly interpret the regulations in the CSA B 149.1 Gas Codes, and vent tables, and Alberta Safety Services Plumbing and Gas Standards that pertain to power assisted vents.

2. State the required power assisted air supply ratio for different applications.

3. State the requirements for the sizing of power assisted air supply needed for different applications.

4. Correctly interpret the regulations in the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards,* manufactures instructions that pertain to special flue applications.

Engineer designed flues ..... *1 Hour*

1. Correctly interpret drawings for engineer designed flues.

2. Identify and describe the operating principles of different types of thermal operated flue dampers.

3. List and describe the installation practices for thermal operated flue dampers.

4. Identify and describe the operating principles of different types of electrically operated flue dampers.

5. List and describe the installation practices for electrically operated flue dampers.

6. Correctly interpret regulations in the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards* that pertain to flue dampers.

D. Stationary Gas Engines ..... **4 Hours**

1. State general requirements for the installation of stationary natural gas and propane fired engines according to CSA B 149.1 Gas Codes.

2. State sizing requirements for stationary gas engines.

3. State additional requirements for engines in excess of 1 000 000 Btuh.

4. State what accompanying equipment is required for normal operation and control according CSA B 149.1 Gas Codes.

5. Correctly interpret regulations from the CSA B 149.1 Gas Codes and requirements for piping engine exhaust and Alberta Safety Services Plumbing and Gas Standards that pertain to exhaust piping serving stationary gas engines.

6. List and describe the requirements for regulator installation according to CSA B 149.1 Gas Codes for natural gas and propane Fuelled Engines in Buildings.

7. List and describe the requirements for relief valves.

8. State the requirements for flexible hose connectors to stationary natural gas and propane-fired engines according to CSA B 149.1 Gas Codes.

9. List and explain the safety practices to be used when installing and servicing gas fired engines:
   a) personal safety
   b) personnel safety
   c) jobsite safety

E. Commercial and Industrial Gas Line Sizing..... 6 Hours

1. Explain the regulation pertaining to the installation of commercial gas supply piping and equipment given in the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards.*

2. Calculate hanger spacing and requirements for different sizes of gas lines and describe labeling requirements.

3. State the regulations in the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards,* which relate to testing gas installations for leaks:
   a) gas lines over 2 psi including secondary gas lines.
   b) finishing piping
   c) appliance piping and manifolds

4. Describe how to test gas lines for leaks and repair leaks where necessary.

5. Demonstrate the various approved methods of testing for gas leaks.

6. List and describe how to test valves and controls for valve let-by.

7. Describe the correct techniques for safely purging gas lines:
   a) replacing air with gas
   b) replacing gas with inerts

8. State the maximum pressure drop allowed across a gas installation for:
   a) 14 inch (3.50 kPa) (review)
   b) 2 psig (14 kPa) (review)
   c) 5 psig (34 kPa)
   d) 10 psig (70 kPa)
   e) 20 psig (140 kPa)

9. List and describe the correct methods for measuring:
   a) standing pressure
   b) operating pressure
   c) manifold pressure
   d) differential
   e) pressure drop

10. List and describe the correct methods for adjusting gas line pressures for:
    a) propane;
    b) natural gas.

11. List and describe the correct methods for adjusting gas appliance manifold pressures for propane and natural gas.

12. State the regulations pertaining to Commercial/Industrial gas line sizing contained in the CSA B 149.1 *Gas Codes and Alberta Safety Services Plumbing and Gas Standards*, for minimum and maximum sizes of gas lines needed in gas installations that will over-rule gas line sizing determined from sizing tables:
    a) natural gas – steel
    b) natural gas – copper
    c) propane gas – steel
    d) propane gas - copper

13. Ascertain layout of gas line in building.

14. Determine the volume of gas consumed by appliances.

15. Determine volume of gas required to be delivered through each portion of the gas line.

16. Determine the length of the gas piping conveying gas.

17. Determine the quantity and types of fittings used in the gas installation.

18. Use a table to determine the equivalent length of pipe to allow for the resistance of the fittings.

19. Calculate the total equivalent length of the gas pipe to be used for sizing the Commercial/Industrial gas line.

20. Determine the type of gas being consumed.

21. State the regulations in the gas codes pertaining to gas pressures in buildings.

22. Determine the correct design pressure for Commercial/Industrial gas lines.

23. Locate the correct table to be used in the CSA B 149.1 Gas Codes or *Alberta Safety Services Plumbing and Gas Standards*.

24. Correctly size gas lines using a gas line sizing table.

25. Interpolate, where necessary, in Commercial/Industrial gas line sizing tables to determine the correct capacity of a gas line, or the correct equivalent length of a gas line, for intermediate values not given in the tables.

26. Describe the approved methods of leak testing and gas detection.

Correction factors

1. Use diversity of load factors for sizing gas lines.

2. Use relative density correction factors for sizing gas lines from the natural gas line sizing tables in the B 149.1 code, where the relative density of the gas conveyed in the line is not 0.6.

SECTION THREE: ..... PROPANE THEORY ..... 16 HOURS

A. Code Interpretation ..... 3 Hours

1. Explain the regulation pertaining to Propane Storage and Handling given in the CSA B 149.2 Gas Code and *Alberta Safety Services Plumbing and Gas Standards*. Interpret applicable regulations in B 31.1 and B 31.3.2. Explain the Scope of the trade.

2. State the responsibility of the installer.

3. List and explain the code requirements pertaining to tank systems, filling plants and refill centers.

4. Explain codes regarding the installation of tank systems.

5. Explain codes regarding the installation of tank system for RV's and mobile vehicles.

B. Tanks, Vaporizers and Pumps ..... 13 Hours

Company bulk storage. ..... 3 Hours

1. Use B 149.1 Gas Code and *Alberta Safety Services Plumbing and Gas Standards* to locate and interpret correct bulk tank location on company property. Interpret applicable regulations in B 31.1 and B 31.3.

2. Use B 149.1 Gas Code and *Alberta Safety Services Plumbing and Gas Standards* to locate and interpret regulations pertaining to the installation of bulk storage facilities on company property.

3. Use B 149.1 Gas Code and *Alberta Safety Services Plumbing and Gas Standards* to locate and interpret regulations pertaining to the site security for bulk facilities.

4. List and describe the valves and accessories used on bulk storage tank installations.

5. Recognize and select valves and accessories used on bulk storage tank installations.

6. Describe the correct installation of valves and accessories on bulk storage tank installation.

7. List and describe routine maintenance to be performed on bulk tank valves and accessories.

8. List and describe the valves and accessories used on bulk trucks.

9. Recognize and select the valves and accessories used on bulk trucks.

10. Describe the correct installation of valves and accessories used on bulk trucks.

11. List and describe routine maintenance to be performed on bulk truck valves and accessories.

12. Use B 149.2 Gas Code and *Alberta Safety Services Plumbing and Gas Standards* to locate and interpret regulations pertaining to the filling of bulk trucks and bulk tanks. Interpret applicable regulations in B 31.1 and B 31.3.

13. Read and interpret dangerous goods route maps for urban areas.

14. List and describe the penalties for disregarding dangerous goods transportation regulations.

15. List and describe the regulations pertaining to the transportation of propane as a hazardous good.

Customer bulk storage tank installations ..... 6 Hours

1. Determine load factors for sizing tanks for customer applications.

2. List and describe the effects of temperature increase and decrease on the pressure of propane in the tank.

3. List and describe the effects that container colour has on the temperature of propane in tanks.

4. List and describe the effects that tank colour has on the vaporization rate from the container.

5. List and describe the effects of filled capacity on the vaporization rate from a propane tank.

6. Calculate vaporization capacity of propane tanks at various different temperatures, colours and filled capacities.

7. State from memory, distances of propane tanks from important buildings, for customer applications.

8. List and describe installation procedures for propane tanks.

9. Use B 149.1 Gas Code and *Alberta Safety Services Plumbing and Gas Standards* to locate and interpret regulations pertaining to the installation of propane tanks on customer property.

10. List and describe routine maintenance procedure to be undertaken to reduce fire hazards and other damage of propane tanks.

11. List and describe the safety valves used on propane tanks.

12. State discharge pressure for propane tank safety relief valves.

13. Use B 149.1 Gas Code and *Alberta Safety Services Plumbing and Gas Standards* to locate and interpret regulations pertaining to the installation of safety valves on propane tanks.

14. State correct location of discharge outlets from safety relief valves.

15. List and describe the use of rain caps on safety relief valves.

16. Calculate the rate of discharge from safety relief valves, in both SI and imperial units.

17. List and describe the valves and accessories used on propane tanks for vapor withdrawal applications.

18. Recognize and identify valves and accessories used on propane tanks for vapor withdrawal applications.

19. Describe the characteristics and features of valves used for vapor withdrawal from propane tanks.

20. List and describe routine maintenance required on valves and accessories used on propane tanks for vapour withdrawal applications.

21. Size excess flow valves for vapor withdrawal.

22. List and describe the valves and accessories used on propane tanks for liquid withdrawal applications.

23. Recognize and identify valves and accessories used on propane tanks for liquid withdrawal applications.

24. Describe the characteristics and features of valves used for liquid withdrawal from propane tanks.

25. List and describe routine maintenance procedures required on valves and accessories used on propane tanks for liquid withdrawal applications.

26. Size excess flow valves for liquid withdrawal.

27. List and describe the use of liquid evacuation valve.

28. List and describe the valves and accessories used on propane tanks for tank filling applications.

29. Recognize and identify valves and accessories used on propane tanks for tank filling applications.

30. Describe the characteristics and features of valves used for tank filling applications.

31. List and describe the routine maintenance procedures required on valves and accessories used on propane tanks for filling applications.

32. State correct filling density of customer propane storage tanks at standard temperature.

33. Use the B 149.1 Propane Code to determine the correct filling density of customer propane storage tanks at various temperatures.

34. Use the filling density capacity scale on float gauges to determine the correct filling capacity of customer propane storage tanks at various temperatures.

35. Calculate the correct filling capacity of customer propane storage tanks using temperature correction factors.

36. List and describe correct vehicle access, parking and preparation for dispensing propane from the bulk truck into customer's propane storage tank at the customer's premises.

37. List and describe correct transfer hose connections from a bulk truck to a customer's propane storage tank for filling and evacuation purposes.

38. List, describe and perform correctly the safety procedures used when transferring propane between bulk truck and customer's tank for filling or evacuation purposes.

39. Correctly fill or evacuate customer's propane storage tanks.

40. List and describe correct filling densities, and perform correct filling density calculations to be used when filling customer's propane storage tank.

41. List, describe and use correctly the safety procedures used to protect self, co-workers, public and the jobsite from exposure to unsafe conditions and possible accidents.

42. List, explain and perform with confidence, emergency procedures to be used in the event of an emergency occurring during a tank filling or evacuation process.

43. List and explain the instructions to be given to the customer for the correct and safe operation, regular maintenance, and general safety procedures to be used in the continued day-to-day operation of customer propane tanks on the customer's property.

44. List and explain the safety and operational procedures to be used by the customer at the customer's property in the event of an emergency occurring.

45. State the regulations contained in the B 149.1 Propane Code and Alberta Plumbing and Gas Safety Bulletin pertaining to the installation of propane tank systems and filling plants.

46. Use the B 149.1 Propane Code and *Alberta Safety Services Plumbing and Gas Standards* to locate and interpret regulations pertaining to the installation and operation of customer propane storage tanks on customer property.

47. List and explain the safety practices to be used when installing and servicing propane tanks and systems:
    a) personal safety
    b) personnel safety
    c) jobsite safety

Propane vaporizers ..... *2 Hours*

1. List, identify and describe the types of propane vaporizer:
    a) direct fired
    b) indirect fired
    c) strap on

2. Identify the sizing and capacity of vaporizers.

3. Size vaporizers for various different capacities, applications and loads.

4. List and describe correct location of vaporizers relative to buildings, propane tank and other obstruction.

5. Describe the correct piping arrangement for direct-fired vaporizers.

6. Describe the correct piping arrangement for indirect fired vaporizers.

7. List and describe the safety controls and devices installed on piping supply, vapor lines and vaporizers.

8. List and describe correct routine maintenance required for direct fired vaporizers.

9. List and describe correct routine maintenance required for indirect fired vaporizers.

10. List and describe routine maintenance required for safety controls used on supply piping, vapor piping and vaporizing.

11. Use the B 149.1 Propane Code and *Alberta Safety Services Plumbing and Gas Standards* to locate and interpret regulations pertaining to the installation and operation of propane vaporizers.

Pumps ..... *2 Hours*

1. List and describe the types of pumps used in the gasfitting industry:
   a) reciprocating
   b) centrifugal
   c) positive displacement

2. Describe the operating principles of different types of pumps.

3. State the applications of different types of pumps in the gasfitter trade.

4. Use pump selection tables to determine discharge heads and suctions on typical pumps.

5. Size pumps from design charts and tables.

6. List and describe correct pump installation procedures for pumps:
   a) propane delivery
   b) hot water heating circulating

7. List and describe the maintenance procedures used for different types of pumps.

8. Explain routine maintenance on different styles of pumps.

9. List problems and describe correction procedures for common pump problems.

10. List and describe the causes of cavitation in propane delivery pumps.

11. List and describe preventative procedures to minimize cavitation in propane pumps.

SECTION FOUR: ..... ELECTRICAL THEORY AND ELECTRONICS ..... 30 HOURS

A. Introduction to Electrical Code and General Rules ..... 4 Hours

1. Explain the purpose of the Canadian Electrical Code Part 1.
2. Identify those responsible for an electrical installation and legal requirements.
3. Become familiar with the administrative rules in Section 2.

B. Electrical Motors Single Phase and Three Phase ..... 6 Hours

1. List and describe the safety precautions that are to be observed when working with electrical equipment on gas appliances and gas controls.
2. Use electrical lockout protection devices on circuit breakers when working on gas appliances and controls with special regard to:
   a) personal safety
   b) personnel safety
   c) jobsite safety
3. List, define and describe common electric motor terminology used in gas appliances.
4. Interpret the data on a typical motor nameplate.
5. List and describe the application of single phase motors
   a) Split phase induction motor
   b) Resistance-start motor
   c) Capacitor-start motor
   d) Permanent-split capacitor motor
   e) Shaded pole induction motor
   f) Dual voltage
6. List and describe the application of three phase motors
   a) Squirrel cage induction motors
   b) Multi speed motors
   c) Describe effects of loading on motors
   d) Dual voltage
7. List and describe periodic maintenance to be completed on electric motors on gas appliances and equipment.
   a) Describe correct oiling procedures for electric motors where necessary.
   b) Adjust pulleys to provide correct fan speed where necessary
   c) Identify burnt out motor
   d) Identify fuse types

C. Electric and Electronic Circuits for Commercial/Industrial Gas Appliances and Gas Controls ..... 16 Hours

1. List, define and describe common electronic terminology used in gas appliance electronic circuits and in gas controls equipment and combined HVAC roof-top units involving both AC and DC electricity.
2. List and describe the common types of electrical circuits found on gas appliances and controls equipment:
   a) series
   b) parallel
   c) combinations of series and parallel circuits
   d) other

3. Solve Ohm's law problems involving simple electrical/electronic circuits for gas appliances and gas controls circuits.

4. Identify the various symbols found on electrical/electronic I wiring diagrams on gas appliances and controls equipment.

5. Match the symbols on electrical/electronic circuits with components on gas appliance and controls equipment.

6. Interpret wiring symbols.

7. List and describe the common types of electronic circuits found on the four categories of gas appliances and controls equipment.

8. Identify and state the applications of D.S.I. and H.S.I.

9. Read wiring diagrams found on various gas appliances and gas controls equipment:
   a) line diagrams
   b) schematic diagram
   c) ladder diagrams
   d) functional diagrams

10. Interpret wiring diagrams found on gas appliances and gas controls equipment for both heating and cooling applications.

11. Analyze gas appliances and gas controls circuits for open/closed contacts and circuits.

12. Interpret timing diagrams found on gas appliances and gas controls equipment for both heating and cooling applications.

13. Interpret sequencing diagrams found on gas appliances and gas controls equipment for both heating and cooling applications.

D. Introduction to Electronic Logic Controls ..... 4 Hours

1. Identify various types of electronic logic controllers used in the gasfitter industry.

2. List and describe the application of electronic logic controllers.

3. Describe the sequence of operation of electronic logic controllers.

4. List and describe the application of programmable logic controllers.

5. List and describe the application of pre-programmable logic controllers.

6. Describe the sequence of operation of programmable/pre-programmable logic controllers.

SECTION FIVE: .....INTRODUCTION TO REFRIGERATION AND AIR CONDITIONING .....8 HOURS

A. Refrigeration Safety ..... 2 Hours

1. List and describe possible hazards when working around combined heating/cooling gas fired appliances.

2. List the sections in the *Occupational Health Safety Regulation*, which impact those working on heating/cooling gas fired appliances.

3. List and describe safe handling requirements for common refrigerants.

4. List and explain the safety practices to be used when working on heating/cooling gas fired appliances:
   a) personal safety
   b) personnel safety
   c) jobsite safety

B. Basic Heating/Cooling Systems..... 6 Hours

1. Describe a basic compression refrigeration cycle.

2. Identify the basic operation of a combined heating/cooling gas fired unit.

3. List and describe the component parts of a combined heating/cooling gas fired unit.

4. Identify basic symbols used in refrigeration schematics.

5. Using wiring diagrams explain the operation of the control circuit.

6. List and describe the function of each control.

7. Identify and explain the sequence of operation of the control system in a heating/cooling gas fired roof top unit.

8. List and describe common maintenance problems associated with combined heating/cooling gas fired units.

SECTION SIX: ..... COMMERCIAL/INDUSTRIAL GAS BURNER CONTROLS ..... 32 HOURS

A. Commercial/Industrial Electro/Mechanical Controls..... 10 Hours

1. Specific controls:
   a) aquastats
   b) safety shut-off gas valves
      i) diaphragm
      ii) fluid drive
      iii) solenoid
      iv) thermally actuated
      v) manual reset
   c) dryer motor start switches
   d) electronic ignition
      i) D.S.I.
      ii) H.S.I.
   e) energy cut off devices
   f) fan switches
   g) flame rods
   h) flame safeguards
   i) flue dampers
   j) high limit switches
   k) fluid power actuators
   l) infra-red detectors
   m) low limit switches and limit controls
   n) photocell
   o) piezo electric ignition
   p) differential pressure switches
   q) pump switches
   r) rectifying pilots
   s) room thermostats
   t) thermally actuated modulating valve
   u) spark ignition
   v) thermal overload switches
   w) thermocouples
   x) thermopiles
   y) ultraviolet detectors
   z) warp switches
   aa) zone damper
   ab) zone valves
   ac) air proving switches
   ad) end switches
   ae) damper motors

2. Identify and name controls that operate Commercial/Industrial gas burner controls.

3. Describe operating principles of control.

4. Determine voltage, amperage, and wattage of control.

5. Match voltage, amperage, and wattage of control to intended application.

6. Calculate switch volt-amp rating needed by control circuit.

7. Match switch volt-amperage to intended application of control.

8. List and describe the correct installation techniques for control.

9. Set and adjust operating set points on control.

10. Diagnose service problems and correct faults.

11. Use test meters and instruments to check the operation of equipment.

12. Use electrical test instruments to measure voltage, amperage, resistance and continuity in electrical circuits as necessary.

13. Install replacement controls where necessary.

14. Test controls for gas leaks.

15. Read and interpret appropriate electrical diagrams pertaining to the installation and maintenance of controls:
    a) line wiring diagrams
    b) schematic wiring diagrams
    c) ladder wiring diagrams
    d) functional diagrams
    e) timing diagrams
    f) sequencing diagrams

B. Flame Safeguard Controls..... 12 Hours

Flame spectrum

1. Describe the flame characteristics (flame spectrum) of the flame safeguard system use in managing safe burner operation:
    a) infrared radiation
    b) visible light radiation
    c) ultraviolet radiation

2. List and describe how the following are used in conjunction with flame safeguard controls:
    a) flame ionization
    b) flame rectification
    c) flame flicker

3. Define the following terms associated with flame safeguards:
    a) primary control
    b) programmed control
    c) lock-out (safety shutdown)
    d) trial for ignition
    e) flame establishing period
    f) flame failure response time
    g) prepurge
    h) postpurge
    i) safe start check
    j) recycling
    k) non-recycling
    l) arc gap protector
    m) pilot link
    n) load relay
    o) flame relay
    p) test jacks
    q) safety lockout device
    r) electronic network

4. Define the following terms associated with programmed controls and interlocks:
    a) timer cycle
    b) ignition trials
    c) early spark termination
    d) run period
    e) firing rate control
    f) start interlock
    g) running interlock
    h) pre-ignition interlock
    i) high purge interlock

5. Identify and name controls that operate Commercial/Industrial gas burner controls:
   a) flame rectifiers (flame rods)
   b) optical detectors (scanners)
   c) light detectors (photocells)
   d infrared detectors or scanners
   e) ultraviolet flame detectors

6. Describe operating principles of each of the controls.

7. Describe the operation of the pilot relight kit.

8. List and describe the component parts of the controls.

9. Explain the first half of cycle and the second half of cycle of the operation of the flame rod.

10. List and describe the differences between the ultraviolet and infrared flame sensors.

11. List and describe the correct installation techniques for controls.

12 Describe the use of electrical test instruments to measure voltage, amperage, resistance and continuity in electrical circuits.

13. Describe operating principles of an air-proving switch.

14. List and describe the component parts of the control.

15. State how the air-proving switch is inter-locked with the flame safeguard control system.

16. Describe the correct operating sequence and characteristics of flame safeguard control systems.

17. List and describe the correct selection of operational programming.

18. List and describe common maintenance problems associated with flame safeguard control systems.

19. State procedures and checks required for upgrading or replacing old or obsolete flame safeguard systems.

20. Use the B 149.1, B 149.2 and B 149.3 Codes and *Alberta Safety Services Plumbing and Gas Standards* to locate and interpret regulations pertaining to the installation and operation of flame safeguard controls.

21. List and explain the safety practices to be used when working on flame safety guard controls:
   a) personal safety
   b) personnel safety
   c) jobsite safety

C. Electronic Circuits for Commercial/Industrial Gas Appliances and Appliance Controls Equipment..... 10 Hours

1. Describe the component parts of a typical pre-package burner management system.

2. List and describe the on/off application of control packages.

3 List and describe the correct special electronic wiring consideration for burner controls.

4. Describe the sequence of operation of the control system.

5. Explain how the safe-start check is electronically performed.

6. List and describe the correct special electronic wiring consideration for dual fuel burner controls.

7. Explain the on/off application of dual fuel control packages.

8. Describe the electronic sequencing when the controls switch from one gas to another.

9. Describe the sequence of operation of the control system.

10. Sketch ladder diagrams for pre-packaged burner management systems.

11. Sketch ladder diagrams for duel fuel burner management systems.

12. Sketch schematic diagrams for duel fuel burner management systems.

13. Sketch schematic diagrams for pre-packaged burner management systems.

SECTION SEVEN: ..... COMMERCIAL/INDUSTRIAL APPLIANCE CONTROL SYSTEMS ..... 20 HOURS

A. Commercial/Industrial Electronic Controls ..... 6 Hours

1. List and describe the controls that input the primary controller on Commercial/Industrial application over 400 MBH:
   a) indoor/out door
   b) night set-back
   c) others

2. List and describe the component parts of each control.

3. Sketch ladder diagrams for the various controls system.

4. Describe the sequence of operation of the controls system.

5. List and describe how each control operates.

6. List and describe common maintenance problems associated with controls that input the primary controller.

B. Commercial/Industrial HVAC Controls ..... 6 Hours

1. Identify roof top systems components both heating and cooling.

2. Read and interpret control diagrams.

3. List and describe control systems serving a rooftop heat/cool package unit.

4. Compare the application of two position controllers and modulating controllers.

5. List and describe the operation of a pneumatic controller.

6. List and describe the operation of electrical and electronic damper motors:
   a) two wire motors and controls
   b) three wire motors and controls
   c) spring return motors

7. Compare the operating characteristics of several roof top heat/cool units.

8. List and describe maintenance and troubleshooting procedures for roof top heat/cool units.

C. Steam and Hot Water Boiler Controls ..... 6 Hours

1. List various types of steam boilers and describe their basic operation.

2. List and identify the controls on a steam boiler that impact upon the operation of the gas burner:
   a) thermostats
   b) high limit pressure control
   c) operating pressure control
   d) indoor/outdoor controller
   e) low water cut off
   f) electrically operated automatic vent damper
   g) safety shut-off valve
   h) flame rollout switch
   i) ASME pressure relief valve
   j) pressure reducing valve
   k) spill switch
   l) other

3. State the code requirements regarding steam boiler gas controls:
   a) B149.1 and B149.2
   b) ASME
   c) ABSA

4. State the basic operation of a gas-fired steam boiler.

5. State the operation of each control.

6. List and describe the sequence of operation of the boiler controls.

7. Sketch ladder diagrams for a gas fired steam boiler.

8. State common maintenance problems associated with gas controls serving steam boilers.

9. State corrective measures.

10. List and describe procedures to be followed when re-commissioning the boiler.

11. List various types of hydronic boilers and describe their basic operation.

12. List and identify the controls on a hydronic heating boiler that impact upon the operation of the gas burner:
   a) thermostats
   b) operating aquastat
   c) high limit aquastat
   d) pumps
   e) low water cut off
   f) electrically operated automatic vent damper
   g) safety shut-off valve
   h) flow switch
   i) flame rollout switch
   j) zone valves
   k) ASME relief valve
   l pressure reducing valve
   m) spill switch
   n) indoor/outdoor
   o) other

13. State the basic operation of a gas-fired hydronic boiler.

14. State the operation of each control.

15. List and describe the sequence of operation of the boiler controls.

16. Sketch ladder diagrams for a gas fired hydronic boiler.

17. State common maintenance problems associated with gas controls serving hydronic heating boilers.

18. State corrective measures.

19. List and describe procedures to be followed when re-commissioning the boiler.

20. List and explain the safety precautions to be used when working with gas-fired steam and hydronic heating boilers:
    a) personal safety
    b) jobsite safety
    c) public safety

D. Computer Application In Control Systems ..... 2 Hours

1. State the application of computers in gas fired appliances and equipment.

2. State how the computer interfaces with the controls system.

3. List and describe how and where the computer is installed in relation to the gas appliance or equipment being served.

4. List and describe wiring and other installation requirements computer serving a gas fired appliance or group of gas fired appliances.

SECTION EIGHT: ..... TROUBLESHOOTING AND SERVICING .....
.....COMMERCIAL/INDUSTRIAL GAS BURNER CONTROL SYSTEMS .....38 HOURS

A. Troubleshooting and Servicing Commercial/Industrial Electrical Controls ..... 16 Hours

1. Specific controls
   a) aquastats
   b) safety shut-off gas valves
      i) diaphragm
      ii) heater motor
      iii) solenoid
      iv) fluid power actuated
      v) pneumatic controls
         i) air
         ii) gas
   c) drier motor start switches
   d) control module
   e) control board
   f) electronic ignition
   g) energy cut off devices
   h) fan switches
   i) flame rods
   j) flame safeguards
   k) flue dampers
   l) high limit switches
   m) hot surface ignition
   n) infra-red detectors#
   o) low limit switches
   p) photocell#
   q) piezo electric ignition
   r) pressure switches
   s) pump switches
   t) rectifying pilots
   u) room thermostats
   v) solenoid valves
   w) spark ignition
   x) thermal overload switches
   y) thermocouples

2. Identify the different Commercial/Industrial gas fired appliances.

3. Identify the wiring diagram and match it to the appliance control system.

4. Determine type of electrical or electronic controls.

5. Determine voltage, amperage and wattage of controls.

6. Match voltage, amperage and wattage of control to intended application.

7. Determine switch volt-amp rating needed by control circuit.

8. Match switch volt-amperage to intended application of control.

9. Set and adjust operating set points on control.

10. Diagnose service problems and correct faults.

11. Use test meters and instrument to check operation of equipment.

12. Measure operation of controls:
    a) thermopiles
    b) ultra-violet detector#
    c) warp switches
    d) zone dampers
    e) zone valves
    f) other appropriate controls

13. Identify and name ignition system controls.
    a) Direct Spark Ignition (D.S.I.)
    b) Hot Surface Ignition (H.S.I.)
    c) Intermittent Pilot Ignition (I.P.I.)

14. Describe the operating principles of each ignition system.

15. Measure operation of controls.

16. List and identify common combustion safety control devices:
    a) flame rectifiers (flame rods)
    b) infrared
    c) ultra violet
    d) photo cell

17. Identify and name controls.

18. Describe the operating principles of each combustion safety control.

19. Describe how the flame signal response is measured.

B. Troubleshooting and Servicing Commercial/Industrial Gas Operated Controls Equipment ..... 14 Hours

1. Specific controls:
    a) liquid bulb thermostats
    b) liquid filled gas pilots
    c) plug valves
    d) pressure regulators
    e) propane cylinder valves
    f) propane tank valves
    g) rod and tube thermostats

2. Identify and name gas operated controls used in Commercial/Industrial applications.

3. Describe operating principles of controls.

4. Correctly size controls where appropriate.

5. List and describe installation techniques for control.

6. Describe how to set and adjust calibration of control.

7. List and describe how to set and adjust bypass on modulating gas controls.

8. Describe proper customer service techniques.

9. Test controls for gas leaks.

Regulators

1. Identify the various ways regulators can be vented.

2. State the application for the following regulators: non-adjustable, minimal adjustable and fully adjustable.

3 Describe the procedure for reducing and increasing gas pressure.

4. Identify the integral safety features of each type of gas pressure regulator.

5. List and identify the different types of gas pressure regulators:
   a) low capacity appliance regulator
   b) high capacity appliance regulator
   c) service regulator
   d) single ported balanced regulator
   e) double ported balanced regulator
   f) servo valves
   g) zero governors
   h) proportional regulator
   i) two-stage regulator system (propane)

6. List and explain the selection requirements for regulators:
   a) rate of flow
   b) type of gas
   c) inlet gas pressure
   d) outlet gas pressure
   e) piping and tubing size

7. Review code and manufacturer information regarding installation, location and piping practices.

8. List and identify corrective measures to be followed when servicing gas regulators.

C. Troubleshooting Burners Commercial/Industrial Application ..... 8 Hours

1. Identify and name gas burner problems that occur in Commercial/Industrial applications.

2. Devise checklist for no gas condition.

3. List and describe procedures for checking for a "low or no gas to burner" condition.

4. List and describe procedures for troubleshooting and checking:
   a) regulators
   b) gas valve
   c) strainer
   d) gas-air mixture
   e) correct pressures at all locations
   f) pilot condition
   g) ignition system
   h) other possible problems

5. Devise checklist for an electrical/electronic condition.

6. List and describe procedures for troubleshooting and checking:
   a) power supply
   b) fuses
   c) limit circuit
   d) correct reading if switch is open or closed
   e) air proving switch
   f) proof of switch closure
   g) damper motor low fire
   h) ignition system
   i) damper motor low fire
   j) damper motor high fire
   k) proof of high fire purge
   l) other possible problems

7. Devise checklist for operating controls.

8. List and describe procedures for troubleshooting and checking:
   a) high limit contacts
   b) operating control
   c) low water cut off (float or electronic)
   d) flow switch
   e) feed water control
   f) air proving switch
   g) ignition system
   h) damper motor low fire
   i) damper motor high fire
   j) proof of high fire purge
   k) other possible problems

SECTION NINE: ..... GAS SHOP AND LAB WORK ..... 48 HOURS

A. Troubleshooting and Servicing Gas Controls, Non Electric Equipment ..... 12 Hours

Specific controls:
   a) liquid bulb thermostats
   b) liquid filled gas pilots
   c) plug valves
   d) pressure regulators
   e) propane cylinder valves
   f) propane tank valves
   g) rod and tube thermostats

1. Determine type of controls used in Commercial/Industrial applications.
2. Adjust operation of control where necessary.
3. Set and adjust the bypass on modulating controls.
4. Diagnose customer complaints and interpret faults.
5. Measure operation of control.
6. Set and adjust calibration of control.
7. Replace faulty control.
8. Test controls for gas leaks and repair or replace where necessary.

B. Troubleshooting and Servicing Gas Controls and Electrical Equipment ..... 12 Hours

1. Wire gas fired appliance control circuits and equipment over 400 MBH electrical/electronic circuits.
2. Wire series circuits.
3. Wire parallel circuits.
4. Wire combinations of series and parallel circuits.
5. Wire circuits for gas appliances and equipment.
6. Install correct wire gauge and insulation temperature rating.

7. Wire extra low voltage circuits and low voltage gas appliance circuits where appropriate:
   a) heating/cooling units
   b) hot water boiler controls
   c) steam boiler controls
   d) flame safeguard circuits
   e) ignition circuits
   f) heating fan circuits
   g) circulating pump circuits
   h) vent damper circuits
   i) air supply circuits
   j) forced vent draft fans

8. Troubleshooting: Follow proper procedures when troubleshooting and servicing gas fired equipment and wiring and check for the following:
   a) short circuits
   b) burnt wires (radiant heat and damaged insulator)
   c) correct wire gauge and insulation temperature rating
   d) all equipment and controls are operating to manufacturers specifications

9. Use lockout and other safety procedures when necessary.

10. List and explain the safety precautions to be used when working with electricity and gas fired controls and equipment:
    a) personal safety
    c) jobsite safety
    d) public safety

C. Test, Adjust and Set Commercial/Industrial Gas Appliances ..... 16 Hours

1. Explain the principles of high pressure meter clocking using pressure factor meters.

2. List and describe the procedures to be followed when using pressure factor metering to determine correct gas consumption of low pressure appliances being clocked through high pressure meters.

3. Measure and adjust gas pressures to appliances over 400 MBH (use systems operation inspection chart).

4. Measure and adjust gas consumption.

5. Set pilot air pressure for each burner.

6. Set main air pressure for each burner on high and low fire.

7. Adjust set and tighten secondary air dampers linkage.

8. Set barometric draft controls when required.

Burner ignition tests (use maintenance procedure work chart)

1. Test the flame safeguard system.

2. Perform an effective ignition tests.

3. Perform a turn down tests when required.

4. Test for correct trial ignition period.

Flame stability tests

1. Perform flame stability tests in cold start-up.
2. Perform flame stability tests in warm start-up.
3. Test turndown ratio.
4. Correctly size orifices.

Service gas controls and equipment

1. Identify the different Commercial/Industrial gas fired appliances.
2. Identify the wiring and match it to the appliances and identify the four basic sections of control systems:
   a) operating controllers
   b) limit and safety controllers
   c) combustion safety controllers
   d) ignition control module
3. Determine type of electrical or electronic controls.
4. Determine voltage, amperage and wattage of controls.
5. Match voltage, amperage and wattage of control to intended application.
6. Determine switch volt-amp rating needed by control circuit.
7. Match switch volt-amperage to intended application of control.
8. Set and adjust operating set points on control.
9. Diagnose service problems and correct faults.
10. Use test meters and instruments to check operation of equipment.
11. Measure operation of controls.
12. Replace faulty controls where required.
13. Follow manufacturer's guidelines for start-up procedures for Commercial/Industrial gas fired applications over 400 MBH.
14. Successfully fire the gas appliance or equipment and make it perform according to codes and manufacturers specifications.
15. Demonstrate safe start-up procedures as outlined in B.149.3

D. Commercial/ Industrial Combustion Analysis ..... 6 Hours

1. Determine the percentage of carbon dioxide in flue gases.
2. Measure flue gas temperature.
3. Measure oxygen in flue gases.

4. Calculate excess air passing through combustion chamber.

5. Determine appliance efficiency.

6. Diagnose reasons for poor efficiency.

7. Measure oxygen in vent.

8. Calculate dilution air passing into vent through draft hood.

9. Plot combustion efficiency.

10. Complete modifications based on flue gas analyses.

11. Set gas appliance to optimum efficiency using combustion analysis data.

E. Regulators Adjustment and Troubleshooting ..... 2 Hours

1. Check for the correct application and installation of the following regulators:
   a) low capacity appliance regulator
   b) high capacity appliance regulator
   c) service regulator
   d) single ported balanced regulator
   e) double ported balanced regulator
   f) servo valves
   g) zero governors
   h) proportional regulator
   i) two-stage regulator system (propane)

2. Check the basic operation of gas pressure regulators.

3. Identify that the regulators are correctly vented.

4. Verify that each regulator is correctly adjusted.

5. Follow correct procedures for reducing and increasing gas pressures.

6 Identify that integral safety features of each type of gas pressure regulator are operating correctly following manufacturer's recommendations and applicable codes.

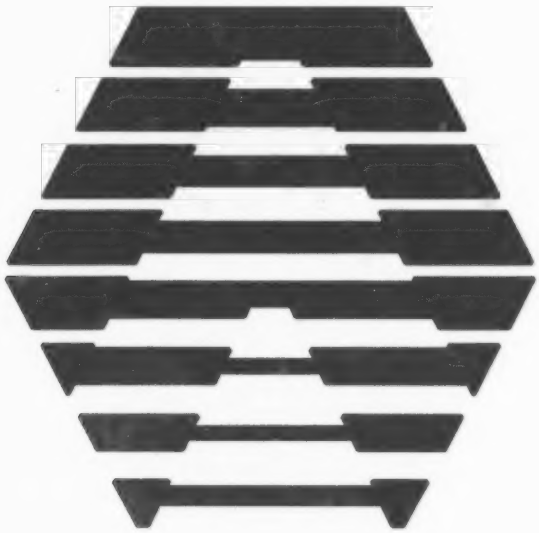
7. List and explain the selection requirements for regulators:
   a) rate of flow
   b) type of gas
   c) inlet gas pressure
   d) outlet gas pressure
   e) piping and tubing size

8. Review code and manufacturer information regarding installation, location and piping practices.

9. List and explain solutions for common gas regulator problems:
   a) obstructed vents
   b) foreign material between seat and disc
   c) corrosion
   d) outlet gas pressure too high
   e) outlet gas pressure too low
   f) slow response
   g) not retaining outlet pressure

10. Use lockout procedures when necessary.

11. List and explain the safety precautions to be used when working with gas regulators:
    a) personal safety
    b) jobsite safety
    c) public safety



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